ILLUMINATING ENGINEERING

MAY 1951

Industrial Lighting

Developments — Trends — Applications

and

Recommended Practices

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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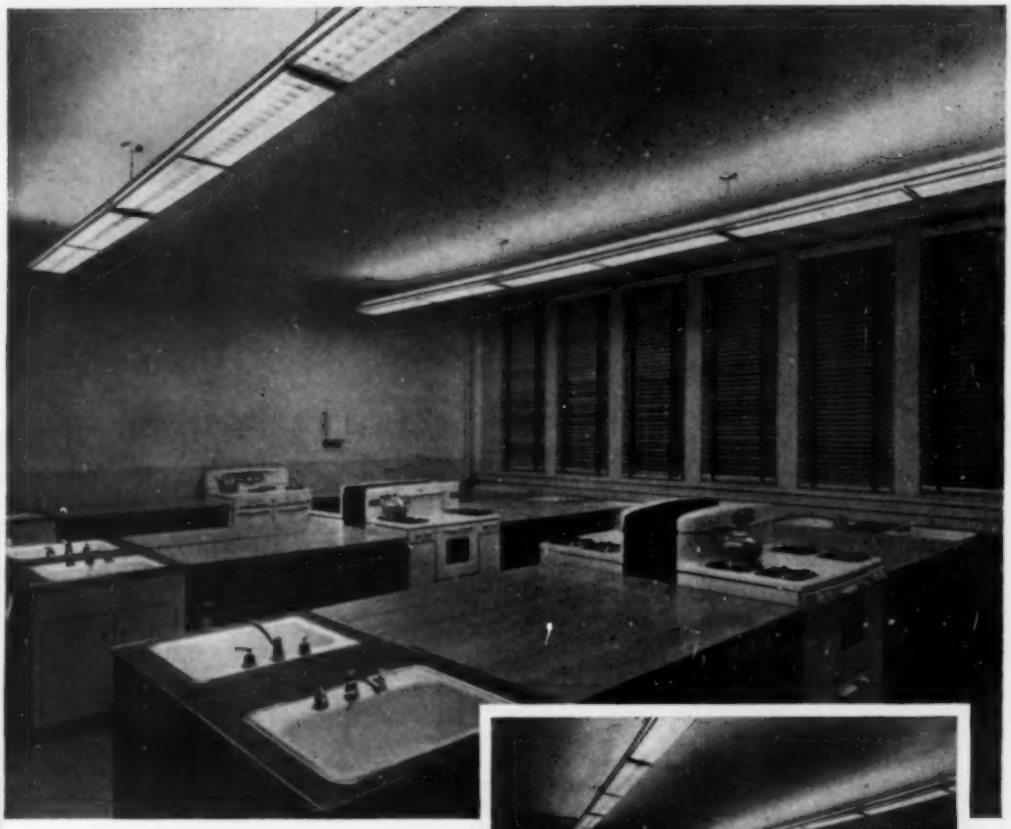

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getting down to brass tacks on industrial lighting . . . . . .

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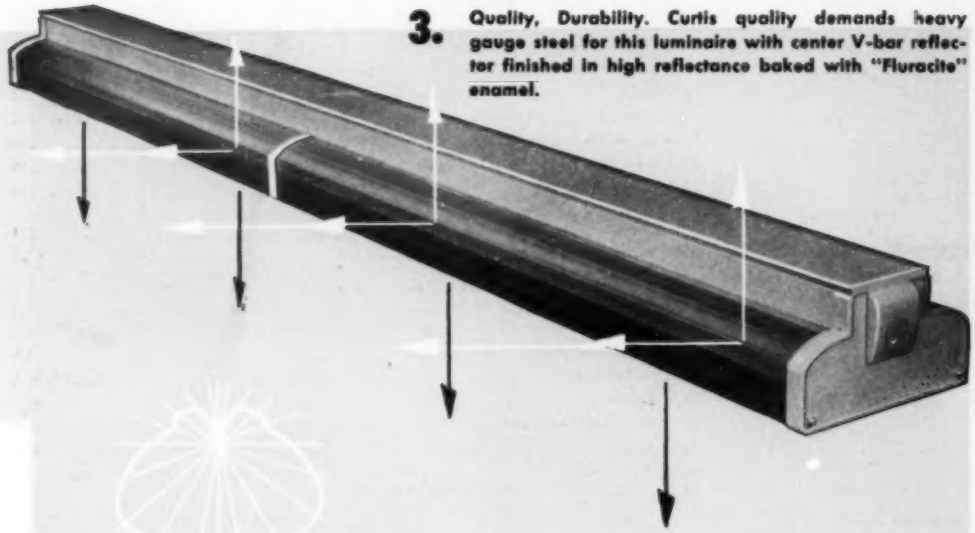

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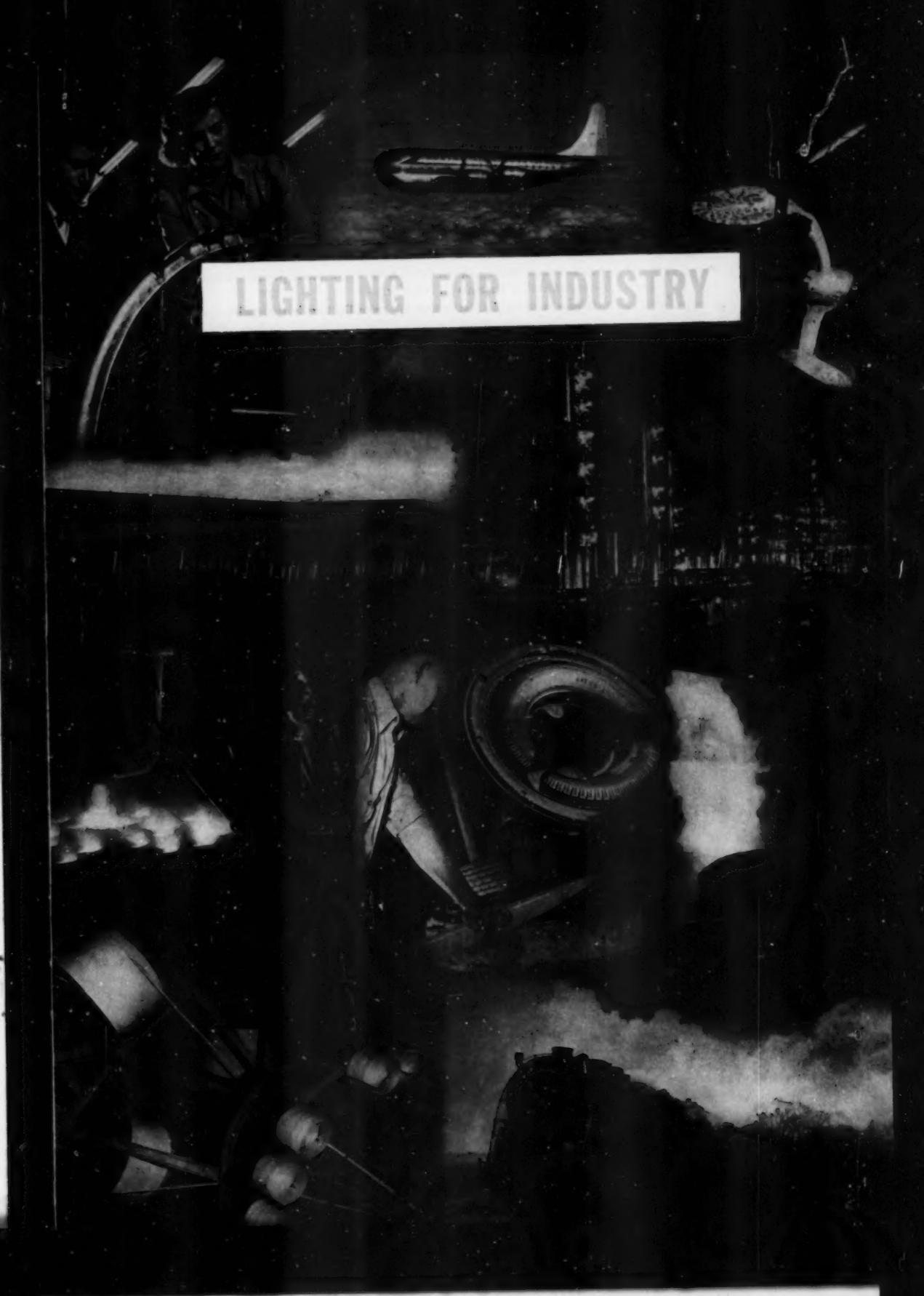
LIGHTING FOR INDUSTRY

On Lighting for Industry

JAMES R. ALLEN, Manager, Industrial Engineering and Construction Department, International Harvester Company

American industrial plants must be operated with maximum efficiency today because of the tremendous demands, not only for civilian requirements, but to meet the ever growing needs of the Government for defense materials, supplies, and equipment. Careful planning of work schedules in the factories, good equipment, and adequate lighting in the work areas will make it possible to meet the tremendous production demands on industry.

Experience has indicated that adequate lighting is essential for maximum production because good lighting contributes to increasing workers' efficiency, improves safety and housekeeping conditions, minimizes possibilities of sabotage and pilferage, improves workers' morale, and last but not least, good lighting is a large factor in insuring better quality of work and minimizing scrap and spoiled work.

GEORGE A. BRYANT, President, The Austin Company

Experience over the past 15 years has clearly established the importance of controlled illumination as a factor in the general improvement of manufacturing techniques and working conditions.

Modern lighting has given industry greater freedom in the development of efficient plant layout. With it, innumerable hazards have been eliminated and the fatigue factor in many visual tasks greatly reduced. Quality standards have been upgraded while the losses due to spoilage have been cut lower and lower.

Great as the gains have been, all-out cooperation between manufacturers of lighting equipment on the one hand and illuminating engineers on the other would have made them even greater. The importance of working together has grown with the progressive refinement of lighting equipment, controls and installation techniques.

Industry is fast giving up the last vestige of dependence on daylight for plant operations. It has done so with the assumption that the combined resources of manufacturers, engineers and builders would be utilized to provide the best lighting obtainable — and to do it at the lowest possible cost. Industry has the right to expect just that.

CARL W. ZERSEN, Managing Director, Chicago Lighting Institute

Our defense leaders have said: we must raise our production capacity — we must build faster and faster and faster and more of everything which helps defense.

How? Do we not already have the greatest industrial production the world has ever known?

Lighting is an additional tool — a factor which aids an already great production machine to build faster and faster and faster. Industrial experience during World War II dispelled any doubt of its significance to industry. Any ignorance of its benefits must be dispelled in this emergency.

The facts are at our disposal. Dissemination of our knowledge, to all who may apply it, can be a major contribution of men and women of the lighting industry. We add to our own store of knowledge through task committees, study groups, reference literature and conferences. We must make our knowledge available through lighting courses, lighting clinics, forums and meetings.

Good lighting in industry is the key to increased production. How to achieve it is our profession. How industry may apply it — for greater success to the stepped-up industrial effort — this is the lighting industry's opportunity to demonstrate that what we have talked about is fact and not fiction. We know the recipe — that in itself accomplishes nothing; but putting the recipe to work — that will prove the worth of the pudding. Let us go all out in putting the demonstrating aids to work, of which our industry has many — and prove over and over that good lighting is one of industry's greatest production tools.

Industrial Lighting Practice Revised

Prepared by the Committee
On Industrial Lighting

Progress in lighting application, development of new techniques, new sources, and new concepts have prompted a revision of the "American Recommended Practice of Industrial Lighting." Parts of that proposed revision are being presented herewith for the interest and study of our readers.

Since brightness relationships in the illuminated environment have become of paramount importance to the efficiency and comfort of seeing, this Practice reflects that underlying concept.

A series of study reports on specific ways of lighting various industrial locations and processes has been developed since the last Practice in 1942. Lighting for the woolen and worsted industry, for flour mills, for canneries, for bakeries, for steel mills, and for machining of small metal parts has been reflected in this new report in the footcandle recommendations and supplementary lighting.

Of course, the fluorescent lamp has been developing in size, output, brightness, color, and operation since the last report. It has brought to many industrial processes a linear source which has aided greatly in diffusing the light into complex machine structures and revealing detail that has been difficult to light. Through the installation of a grid system of orientation of fluorescent luminaires broad highlights in metal surfaces are being reflected to delineate detail on such surfaces.

It is hoped that this revision will become even more popular than the last. The last one was approved as an American Standard in 1942 and received wide acceptance throughout the United States and Canada and aided greatly in industrial production during World War II. The Canadian Department of Labor adopted it, and it was issued under the title of "Recommended Practice of Industrial Lighting." It was also approved by the Canadian Engineering Standards Association in 1943. The U. S. Department of Labor used it as the basis of recommendations. The U. S. Navy Department used it as a standaard for the lighting of its industrial facilities. The State of Washington made it a part of State regulations. Some 52 thousand copies were distributed in the United States and Canada.

The following material is part of a draft being presented to the American Standards Association's Sectional Committee on Industrial Lighting for its consideration and possible development into the final approved American Standard. Suggestions and comments will be welcomed toward refinement into its finished form.

I.E.S. Industrial Lighting Committee.

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1. Introduction

The purposes of industrial lighting are to help provide a safe working environment, to provide efficient and comfortable seeing as an aid to all types of industrial operation, and to aid in the conservation of vision and energy. It is important, therefore, to analyze the several factors which contribute to seeing; that is, the *task*, the *environment*, and the *lighting*. While in practice these factors are closely inter-related, they are for practical considerations individually treated in this publication.

2. General Conditions

2.1—*Factors Affecting the Seeing Tasks of Industry*

2.1.1—*General*—The seeing tasks encountered in industry vary widely in what they require of the eyes for successful accomplishment. The ability of the eyes to do the job is primarily dependent upon the visibility of the work but modified by the human being himself. The visibility of a task or object is determined by its *size*, *brightness*, *contrast* to background, and *time* of viewing. The human eye is affected by age, subnormal vision, and the state of adaption. Subnormal eyes benefit much more in percentage gain than normal eyes with improvements in illumination. Each of these factors is sufficiently dependent upon the others that a deficiency in one may be compensated (within limits) by augmenting one or more of the others.

2.1.2—*Size*—As size increases, visibility increases, and up to a certain point seeing becomes easier. If the size of an object is too small to be visible to the naked eye, a magnifying glass or a microscope is usually used. Sometimes the work is merely held closer to the eyes which, in effect, increases visual size. More light is oftentimes effective in making fine details more easily seen.

2.1.3—*Brightness*—The factors of size and contrast are inherent in the task itself and, within limits, time of viewing may be considered in this same category. Therefore, in general, brightness is important as the one controllable factor. Brightness resulting from the light on the task and its surroundings in the visual field may be controlled within wide limits by varying the amount and distribution of light. The brightnesses needed for good seeing are usually many times those necessary for mere discernment; with higher brightness one may to some extent compensate for deficiencies in the other factors.

2.1.4—*Contrast*—To be readily visible each critical detail of the seeing task must differ in brightness (or color) from the surrounding background. If discrimination is dependent solely on brightness differences, visibility is a maximum when the contrast of details with the background is the greatest. For example, the brightness contrast of the black printed letters against the white background of this page is high. Conversely, the brightness contrast of black thread on dark cloth is very low. In correlating this factor of brightness contrast with other factors, it is noted that the minimum size of an object which is barely visible is many times smaller when the brightness contrast is high than when it is low. Therefore, within the limits available to industry, the contrast of seeing tasks, i.e., between the object of regard and its immediate background, should be made as high as possible. Where it is impractical to provide good contrast conditions high levels of illumination help compensate for the poor contrast.

2.1.5—*Time of Viewing*—The speed with which a man can do his job is very often a measure of his productiveness. Time is spent in determining the job to be done and checking on the actual operation. If low brightnesses prevail it will take a relatively long time to accomplish the seeing task. By increasing brightness, time required for seeing will be shortened. In the same sense, seeing tasks of high contrast and large size will generally require less time than tasks of low contrast and small size.

TABLE I.—GENERAL RECOMMENDED VALUES OF ILLUMINATION.

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
MOST DIFFICULT SEEING TASKS	
Finest Precision Work	200-1000
Involving: Finest Detail Poor Contrasts Long Periods of Time	
Such as: Extra-fine Assembly; Precision Grading; Extra-fine Finishing	
VERY DIFFICULT SEEING TASKS	
Precision Work	100
Involving: Fine Detail Fair Contrasts Long Periods of Time	
Such as: Fine Assembly; High-Speed Work; Fine Finishing	
DIFFICULT AND CRITICAL SEEING TASKS	
Prolonged Work	50
Involving: Fine Detail Moderate Contrasts Long Periods of Time	
Such as: Ordinary Bench Work and Assembly; Machine Shop Work; Finishing of Medium-to-Fine Parts; Office Work	
ORDINARY SEEING TASKS	
Involving: Moderately Fine Detail Normal Contrasts Intermittent Periods of Time	30
Such as: Automatic Machine Operation; Rough Grading; Garage Work Areas; Switchboards; Continuous Processes; Conference and File Rooms; Packing and shipping	
CASUAL SEEING TASKS	
Such as: Stairways; Reception Rooms, Washrooms and other Service Areas; Active Storage	10
ROUGH SEEING TASKS	
Such as: Hallways; Corridors; Passageways; Inactive Storage	5

2.1.6—*Age and Subnormal Vision*

2.1.6.1—*General*—It is a commonly accepted fact that there is a degeneration of bodily functions with age. The eyes are no exception, but no two eyes are the same. The degeneration of vision with age can be approached from several viewpoints.

2.1.6.2—*Pupil Size*—The size of the pupil decreases with age so that higher brightness of object is required to create the same degree of brightness on the retina of older eyes as obtained with younger eyes having larger pupils. It is possible to establish the brightness necessary to compensate for the loss of pupil size of an older person as compared with a 20-year-old "normal" eye.

2.1.6.3—*Accommodation*—Accommodation is the adjustment of the lens of the eye to fix upon objects at different distances. Age tends to flatten the lens permanently; near-sighted persons cannot accommodate for vision without correction. The ability of an eye, old or young, normal or subnormal, to accommodate is improved with increases in illumination, with the greatest improvement shown for the eye with subnormal accommodation.

2.2—*Factors of Good Illumination*

2.2.1—*General*—Because of the many factors involved in good illumination, lighting installations should be designed by a competent illuminating engineer. Reduced to its simplest terms the factors to be considered can be summed up under the headings of *quantity*, the amount of illumination which produces brightness of the task and surroundings, and *quality*, which includes the color of light, its direction, diffusion, absence of glare, etc.

2.2.2—*Quantity of Illumination*—(a) The desirable quantity of light for any particular installation depends primarily upon the work which is being done. The degree of accuracy required, the fineness of detail to be observed, the color and the reflectivity of the work, as well as the immediate surroundings, materially affect the brightness requirements which will produce maximum seeing conditions. Investigations in the field and laboratory have indicated that as the illumination of the task (and hence its brightness) is increased, the ease, speed, and accu-

racy with which the task can be accomplished are increased. These tests have not yet established an upper limit, but the harmful effects of low footcandles are well known.

(b) The lighting recommendations in Table I are based on the characteristics of the visual tasks and the performance requirements. Values are given in accordance with the difficulty of the various seeing tasks and are higher for work such as detailed assembly, fine layout and bench work, and tasks involving low contrast. The more casual or intermittent tasks are assigned lower values. It should be noted that the tasks involving fine detail and poor contrast usually involve prolonged work periods.

(c) To insure that a given illumination will be maintained even where maintenance conditions are favorable, it is necessary to design the system to give initially more light than the recommended in-service level. The system should be designed initially at least 50% above the in-service level. Where safety goggles are worn, the light reaching the eye is likely to be materially reduced, and the level of Where safety goggles are worn, the light reaching the eye is likely to be materially reduced, and the level of lighting should, therefore, be increased in accordance with the absorption of the goggle in use. It is important that the quantity of light be measured at the point and in the plane at which the seeing task is performed, be it horizontal, vertical, or some intermediate angle.

(d) The Illuminating Engineering Society has in recent years been studying the illumination needs of specific industries. The results of those studies which have been completed are included in Table II.

2.2.3—*Quality of Lighting*

2.2.3.1—*General*—**(a)** The factors involved in quality of lighting are many and complex. Glare, diffusion, direction and uniformity of distribution, color, brightness and brightness ratios have a significant effect upon visibility and ability to see easily, accurately, and quickly. Certain seeing tasks require much more careful analysis and higher quality lighting than others. Areas where the seeing tasks are casual or relatively infrequent need high quality lighting much less than areas where the seeing tasks are severe and are performed over long periods of time. Good appearance of certain areas also often dictates the use of high quality lighting even though the seeing tasks in the area are not difficult. Lobbies, auditoriums, etc. usually fall into this class.

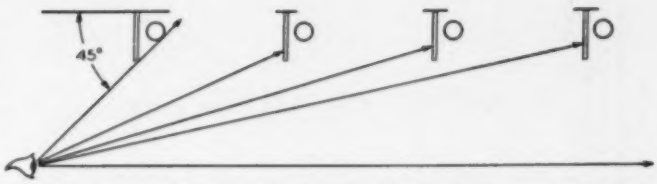

Figure 1. To protect the eyes in the potential direct glare zone, luminaires should be shielded to about 45 degrees, as illustrated.

(b) Installations extremely deficient in lighting quality are easily recognized as very uncomfortable and even harmful. Unfortunately, more moderate deficiencies are not readily detected, although the cumulative effect of even slightly glaring conditions can result in material loss of seeing efficiency and in undue fatigue.

2.2.3.3—*Direct Glare*—**(a)** Glare may be defined as any brightness within the field of vision of such character to cause discomfort, annoyance, interference with vision or eye fatigue, or both. When the condition is caused directly by the source of the lighting, whether natural or artificial, it is described as direct glare.

(b) To reduce direct glare, the following steps may be taken:

(1) Decrease the *brightness* of light sources or lighting equipment, or both.
(2) Reduce the *area* of high brightness causing the glare condition.
(3) Increase the *angle* between the glare source and the line of vision.
(4) Increase the *brightness* of the area surrounding the glare source and against which it is seen.

(c) Unshaded windows are frequent cause of direct glare. They may permit direct view of the sun, bright portions of the sky, and of bright adjacent buildings. These often constitute large areas of very high brightness in the normal field of view. The condition may be controlled by shading the windows with shades, blinds, louvers, or baffles.

(d) Artificial lighting luminaires which are too bright for the environment in which they are located produce direct glare. To reduce this glare, direct general-lighting luminaires should be mounted at sufficient height to keep them well above the normal line of vision. They should be properly designed to limit both the brightness and the quantity of light emitted in directions directly below the horizontal since such light is likely to be well within the field of view and interfere with vision. There is such a wide divergence of conditions in industry that it is necessary to modify the ideal luminaire characteristics to meet practical limitations of efficiency and maintenance. In offices and in industrial areas where similar environmental conditions can be established, a shielded zone from horizontal to approximately 45° below is recommended in accordance with the "Recommended Practice of Office Lighting" (See Fig. 1). It is always desirable to provide as large a shielded zone as practicable. Ideally, from Sec. 2.3.1, the brightnesses of the room should be relatively uniform including the luminaire. This condition is usually difficult to achieve particularly with the direct lighting equipment most frequently used in industry. Usually the surfaces above the lighting equipment and the upper surfaces of the luminaire are much too low in brightness. The condition is improved by the use of white finishes on these surfaces and the provision for more light to be incident upon them. For this purpose it is desirable that the luminaire supply an upward component of the order of 10 per cent, or that auxiliary units directing a comparable amount of light upward be employed. Light finishes throughout the room interior—especially floors—materially assist in adding illumination to the upper room surfaces through interreflection.

For areas where good environmental conditions are practical the maximum brightness of the luminaire in the

(Text continued on page 233)

TABLE II.—SPECIFIC RECOMMENDED VALUES OF ILLUMINATION.

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
AIRPLANE MANUFACTURING:	
Stock Parts —	
Production	50
Inspection	100
Parts Manufacturing —	
Drilling, Riveting and Screw Fastening	50
Spray Booths	50
Sheet Aluminum Layout and Template Work; Shaping and Smoothing of Small Parts for Fuselage; Wing Sections, Cowling, etc.	50
Welding —	
General Illumination	30
Supplementary Illumination	1000
Sub-Assembly —	
Landing Gear, Fuselage, Wing Sections, Cowling and Other Large Units	30
Final Assembly —	
Placing of Motors, Propellers, Wing Sections and Landing Gear	30
Inspection of Assembled Ship and its Equipment	50
Machine Tool Repairs	100
ASSEMBLY:	
Rough	20
Medium	50
Fine	100
Extra Fine	300*
AUTOMOBILE MANUFACTURING:	
Assembly Line	100
Frame Assembly	30
Body Manufacturing —	
Parts	20
Assembly	30
Finishing and Inspecting	200*
BAKERIES (From I.E.S. Report "Lighting for Bakeries"):	
Mixing Room	20
Face of shelves (vertical illumination)	10
Inside of mixing bowl (vertical mixers)	50*
Fermentation Room	10
Make-up Room	
Bread	20
Sweet yeast raised products	30
Proofing Room	10
Oven Room	20
Fillings and Other Ingredients	30
Decorating and Icing	
Mechanical	20
Hand	50*
Scales and Thermometers	30
Wrapping Room	20
Storage Room	10
Shipping Room	20
Offices	50
Reception Rooms	10
Washrooms, Stairways	10
Halls, Corridors, Passageways	5
BOOK BINDING:	
Folding, Assembling, Pasting, etc.	20
Cutting, Punching and Stitching	30
Embossing	30
BREWERIES:	
Brew House	5
Boiling, Keg Washing and Filling	10
Bottling	20
BUILDING:	
Construction	10
Excavation Work	2
CANDY MAKING:	
Box Department	20
Chocolate Department —	
Husking, Winnowing, Fat Extraction, Crushing and Refining, Feeding	10
Bean Cleaning and Sorting, Dipping, Packing, Wrapping	20
Milling	50
Cream Making —	
Mixing, Cooking and Molding	20
Gum Drops and Jellied Forms	20
Hand Decorating	50
Hard Candy —	
Mixing, Cooking and Molding	20
Die Cutting and Sorting	50
Kiss Making and Wrapping	50
Special Holiday Candy—Hand Decorating	50
CANNING AND PRESERVING (From I.E.S. Report "Lighting for Canneries"):	
Receiving	
Grading Raw Material Samples	20
Tomatoes	100
Preparation	
Preliminary Sorting	
Apricots and Peaches	50
Tomatoes	100
Olives	125
Cutting and Pitting	35
Final Sorting	100
Canning	
Continuous Belt Canning	100
Sink Canning	100
Hand Packing	20
Olives	50
Container Handling	
Inspection	150***
Storage and Warehouse	
Can Unscramblers	10 (Well Diffused)
Inspection	150***
Washrooms and Stairways	10
Corridors	5

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated on p. 234.

**These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. To provide the required illumination, a combination of the general lighting indicated plus specialized supplementary lighting is necessary. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion, and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

***Special lighting such that (1) the luminous area shall be large enough to cover the surface which is being inspected and (2) the brightness be within the limits necessary to obtain comfortable contrast conditions. This involves the use of sources of large area and relatively low brightness in which the source brightness is the principal factor rather than the footcandles produced at a given point.

TABLE II.—(Continued)

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
CHEMICAL WORKS:	
Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary and Gravity Crystallizers	5
Mechanical Furnaces, Generators and Stills, Mechanical Driers, Evaporators, Filtration, Mechanical Crystallizers, Bleaching	10
Tanks for Cooking, Extractors, Percolators, Nitrators, Electrolytic Cells	20
CLAY PRODUCTS AND CEMENTS:	
Grinding, Filter Presses, Kiln Rooms	5
Molding, Pressing, Cleaning and Trimming	20
Enameling	30
Color and Glazing	30
CLEANING AND PRESSING INDUSTRY:	
Checking and Sorting	20
Dry and Wet Cleaning and Steaming	10
Inspection and Spotting	200*
Pressing —	
Machine	30
Hand	50
Receiving and Shipping	10
Repair and Alteration	200*
CLOTH PRODUCTS:	
Cutting, Inspecting, Sewing —	
Light Goods	30
Medium Goods	100
Dark Goods	300*
Pressing, Cloth Treating (Oil Cloth, etc.) —	
Light Goods	30
Medium Goods	50
Dark Goods	100
COAL TIPPLES AND CLEANING PLANTS:	
Breaking, Screening and Cleaning	10
Picking	300*
CONSTRUCTION — INDOOR:	
General	10
DAIRY PRODUCTS:	
Fluid Milk Industry —	
Boilers	10
Bottle Storage	10
Bottle Sorting	50
Bottle Washers	300***
Can Washers	20
Cooling Equipment	20
Filling: Inspection	50
Gages	30 (on face)
Laboratories	50
Loading Platforms	10
Meter Panels	30 (on face)
Pasteurizers	20
Receiving Room	30
Scales	30
Separators	20
Storage Refrigerator	10
Tanks	
Light Interiors	10
Dark Interiors	100
Thermometer	30 (on face)
Vats	50
Weighing Room	10
ELECTRICAL EQUIPMENT MANUFACTURING:	
Impregnating	30
Insulating: Coil Winding	100
Testing	50
ELEVATORS — FREIGHT AND PASSENGER	10
ENGRAVING (WAX)	100*
EXPLOSIVES:	
Hand Furnaces, Boiling Tanks, Stationary Driers, Stationary and Gravity Crystallizers	5
Mechanical Furnaces, Generators and Stills, Mechanical Driers, Evaporators, Filtration, Mechanical Crystallizers	10
Tanks for Cooking, Extractors, Percolators, Nitrators	20
FLOUR MILLS (From I.E.S. Report "Lighting for Flour Mills"):	
Rolling	40
Sifting	40
Purifying	40
Packing	30
Product Control	40
Cleaning Screens, Man Lifts, Aisleways and Walkways, Bin Inspection	20
FORGE SHOPS (AND WELDING)	10
FOUNDRIES:	
Annealing (furnaces)	10
Cleaning	20
Core making (fine)	50
Core making (medium)	25
Grinding and chipping	30**
Inspection (fine)	100
Inspection (medium fine)	50
Inspection (medium)	30
Moulding (medium)	50
Moulding (large)	30
Pouring	10
Sorting	10
Storage	10
Shipping and receiving	30
Cupola	10
Shakeout	10
GARAGES — AUTOMOBILE AND TRUCK:	
Storage — Live	10
Storage — Dead	2
Repair Department and Washing (Pits or Lifts)	50

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated on p. 234.

**These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. To provide the required illumination, a combination of the general lighting indicated plus specialized supplementary lighting is necessary. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion, and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

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TABLE II.—(Continued)

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
GLASS WORKS:	
Mix and Furnace Rooms, Pressing and Lehr, Glass Blowing Machines	10
Grinding, Cutting Glass to Size, Silvering	30
Fine Grinding, Polishing, Beveling, Etching and Decorating	50
Inspection	100
GLOVE MANUFACTURING:	
Pressing, Knitting, Sorting —	
Light Goods	20
Medium Goods	50
Dark Goods	100
Cutting, Stitching, Trimming, Inspection —	
Light Goods	30
Medium Goods	100
Dark Goods	200*
HANGARS — AIRPLANE:	
Storage — Live	10
Repair and Servicing	50
HAT MANUFACTURING:	
Dyeing, Stiffening, Braiding, Cleaning and Refining —	
Light	20
Medium	50
Dark	100
Forming, Sizing, Pouncing, Flanging, Finishing and Ironing —	
Light	30
Medium	50
Dark	100
Sewing —	
Light	30
Medium	100
Dark	200*
ICE MAKING — ENGINE AND COMPRESSOR ROOM	10
INSPECTION:	
Rough	20
Medium	50
Fine	100
Extra Fine	200*
IRON AND STEEL MANUFACTURING:	
Open Hearth —	
Stock Yard	5
Charging Floor	10
Pouring Slide	
Slag Pits	20
Control Platforms	20
Mold Yard	5
Hot Top	20
Hot Top Storage	10
Checker Cellar	5**
Buggy and Door Repair	20
Stripping Yard	10
Scrap Stockyard	10
Mixer Building	20
Calcining Building	10
Skull Cracker	5
Cinder Dump	5
JEWELRY AND WATCH MANUFACTURING	200*
LAUNDRIES:	
Washing	20
Flatwork Ironing, Weighing, Listing and Marking	20
Machine and Press Finishing, Sorting	30
Fine Hand Ironing	50
LEATHER MANUFACTURING:	
Vats	5
Cleaning, Tanning and Stretching	10
Cutting, Fleshing and Stuffing	20
Finishing and Scarfing	30
LEATHER WORKING:	
Pressing, Winding and Glazing —	
Light	30
Medium	50
Dark	100
Grading, Matching, Cutting, Scarfing, Sewing —	
Light	30
Medium	100
Dark	200*
LOCKER ROOMS	10
MACHINE SHOPS:	
Rough Bench and Machine Work	20
Medium Bench and Machine Work, Ordinary Automatic Machines, Rough Grinding, Medium Buffing, and Polishing	50
Fine Bench and Machine Work, Fine Automatic Machines, Medium Grinding, Fine Buffing and Polishing	100
Extra Fine Bench and Machine Work, Grinding — Fine Work	200*
MEAT PACKING:	
Slaughtering	10
Cleaning, Cutting, Cooking, Grinding, Canning, Packing	20
OFFICES:	
Difficult Seeing Tasks	50
Auditing and Accounting	
Business Machine Operation	
Transcribing and Tabulation	
Bookkeeping	
Drafting	
Designing	
Ordinary Seeing Tasks	30
General Office Work (except for work coming under "Difficult Seeing Tasks" above)	
Private Office Work	
General Correspondence	
Conference Rooms	
Active File Rooms	
Mail Rooms	

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated on p. 236.

**These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. To provide the required illumination, a combination of the general lighting indicated plus specialized supplementary lighting is necessary. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion, and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

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TABLE II.—(Continued)

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
Casual Seeing Tasks	10
Inactive File Rooms	
Reception Rooms	
Stairways	
Washrooms, and other Service Areas	
Simple Seeing Tasks	5
Hallways and Corridors	
Passageways	
PACKING AND BOXING	10
PAINT MANUFACTURING:	
General	20
Comparing Mix with Standard	100**
PAINT SHOPS:	
Dipping, Simple Spraying, Firing	20
Rubbing, Ordinary Hand Painting and Finishing Art, Stencil and Special Spraying	20
Fine Hand Painting and Finishing	50
Extra Fine Hand Painting and Finishing (Automobile Bodies, Piano Cases, etc.)	100***
PAPER BOX MANUFACTURING:	
Light	20
Dark	50
Storage	5
PAPER MANUFACTURING:	
Beaters, Grinding, Calendering	10
Finishing, Cutting, Trimming Paper-Making Machines	20
Hand Counting, Wet End of Paper Machine	30
Paper Machine Reel, Paper Inspection and Laboratories	50
Rewinder	100
Storage	5
PLATING	10
POLISHING AND BURNISHING	20
POWER PLANTS, ENGINE ROOM, BOILERS:	
Boilers, Coal and Ash Handling, Storage Battery Rooms	5
Auxiliary Equipment, Oil Switches and Transformers	20
Engines, Generators, Blowers, Compressors	20
Switchboards	30
PRINTING INDUSTRIES:	
Type Foundries —	
Matrix Making, Dressing Type	100
Font Assembly — Sorting	50
Hand Casting	30
Machine Casting	20
Printing Plants —	
Presses	30
Imposing Stones	100***
Proof Reading	100
Electrotyping —	
Molding, Finishing, Leveling Molds, Routing, Trimming	100
Blocking, Tinning	30
Electroplating, Washing, Backing	20
Photo Engraving —	
Etching, Staging	20
Blocking	30
Routing, Finishing Proofing	50
Tint Laying	100
Masking	100
Receiving and Shipping	10
RUBBER TIRE AND TUBE MANUFACTURING:	
Stock Preparation —	
Branbury	20
Plasticating	20
Milling	20
Calendering	30
Fabric Preparation —	
Stock Cutting	30
Bead Building	30
Tube Tubing Machines	20
Tread Tubing Machines	20
Tire Building —	
Solid Tire	20
Pneumatic Tire	50
Curing Department —	
Tube Curing	50
Casing Curing	50
Final Inspection —	
Tube	50
Casing	100
Wrapping	20
Warehouse	5
RUBBER GOODS — MECHANICAL:	
Stock Preparation —	
Plasticating	20
Milling	20
Calendering	30
Branbury	20
Fabric Preparation —	
Stock Cutting	30
Hose Looms	30
Molded Products and Curing	50
Extruded Products	30
Inspection	100
Boxing	20
Warehouse	5
SHEET METAL WORKS:	
Miscellaneous Machines, Ordinary Bench Work	20
Presses, Shears, Stamps, Spinning, Medium Bench Work	20
Punches	25
Tin Plate Inspection	50
Scribing	100***
SHIP YARDS:	
General	5
Ways and Fabrication Areas	10

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TABLE II.—(Continued)

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
SHOE MANUFACTURING (LEATHER):	
Cutting and Stitching —	
Cutting Tables	20
Marking, Buttonholing, Skiving, Sorting, Vamping and Counting —	
Light Materials	20
Dark Materials	100
Stitching —	
Light Materials	30
Dark Materials	200*
Making and Finishing —	
Stitchers, Nailers, Sole Layers, Welt Beaters and Scarfers, Trimmers, Welters, Lasters, Edge Setters, Sluggers, Randers, Wheelers, Treers, Cleaning, Spraying, Buffing, Polishing, Embossing —	
Light Materials	20
Dark Materials	100
Storage, Packing and Shipping	10
SHOE MANUFACTURING (RUBBER):	
Washing, Coating, Mill Run Compounding	10
Varnishing, Vulcanizing, Calendering, Upper and Sole Cutting	30
Sole Rolling, Lining, Making and Finishing Processes	50
SOAP MANUFACTURING:	
Kettle Houses, Cutting, Soap Chip and Powder	10
Stamping, Wrapping and Packing, Filling and Packing Soap Powder	20
STAIRWAYS, PASSAGEWAYS	5
STONE CRUSHING AND SCREENING:	
Belt Conveyor Tubes, Main Line Shafting Spaces, Chute Rooms Inside of Bins	5
Primary Breaker Room, Auxiliary Breakers under Bins	5
Screens	10
STORAGE BATTERY MANUFACTURING:	
Molding of Grids	20
STORAGE AND STOCK ROOMS:	
Rough Bulky Material	5
Medium	10
Fine Material Requiring Care	20
STRUCTURAL STEEL FABRICATION	10
SUGAR REFINING:	
Grading	30
Color Inspection	100
TESTING:	
Rough	20
Fine	30
Extra Fine Instruments, Scales, etc.	100
TEXTILE MILLS (COTTON):	
Opening, Mixing, Picking, Carding and Drawing	10
Slubbing, Roving Spinning	20
Spooling, Warping on Comb	20
Beaming and Slashing on Comb —	
Grey Goods	20
Denims	50
Inspection —	
Grey Goods (Hand Turning)	50
Denims (Rapidly Moving)	100**
Automatic Tying-in, Weaving	100
Drawing-in by Hand	100**
Weaving	50
TEXTILE MILLS (SILK AND RAYON):	
Manufacturing —	
Soaking, Fugitive tinting, and Conditioning or Setting of Twist	10
Winding, Twisting, Rewinding, and Coning, Quilling, Slashing	30
Warping (Silk or Cotton System) on Creel, on Running Ends, on Reel, on Beam, on Warp at Beaming	50
Drawing-in —	
On Heddles	100
On Reed	100
Weaving —	
On Heddles and Reeds	10
On Warp Back of Harness	20
On Woven Cloth	30
TEXTILE MILLS (WOOLEN AND WORSTED) (From I.E.S. Report "Lighting for Woolen and Worsted Textile Mills")	
Opening	15
Grading	100*
Blending	15
Picking	15
Carding (Add an internal unit)	35
Combing	35
Recombing	35
Gilling	35
Drawing (white)	25
Drawing (colored)	50
Spinning (Frame) (White)	25
" " (Colored)	50
Spinning (Mule) (White)	20
" " (Colored)	40
Twisting (White)	25
" (Colored)	50
Winding (White)	20
" (Colored)	40
Warping (White)	20
" " (at Reed)	75*
" (Colored)	40
" " (at Reed)	75*
Weaving (White)	40
" (Colored)	80
Grey Goods Room —	
Burling	100*
Sewing	200*
Folding	40

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated on p. 234.

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TABLE II—(Continued)

	Current Recommended Practice Footcandles in Service (On Task or 30" above floor)
Wet Finishing—	
Fulling	25
Securing	25
Crabbing	25
Drying	25
Dyeing	100*
Dry Finishing—	
Napping	40
Shearing	100*
Conditioning	40
Pressing	40
Inspecting (Perching)	300
Folding	40
TOBACCO PRODUCTS:	
Drying, Stripping, General	10
Grading and Sorting	100
TOILETS AND WASH ROOMS	10
UPHOLSTERING — AUTOMOBILE, COACH FURNITURE	30
WAREHOUSE	5
WELDING:	
General Illumination	30
Supplementary Illumination	1000
WOODWORKING:	
Rough Sawing and Bench Work	30
Sizing, Planing, Rough Sanding, Medium Machine and Bench Work, Glueing, Veneering, Cooperage	50
Fine Bench and Machine Work, Fine Sanding and Finishing	100

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated on p. 234.

shielded zone should be less than 1 candle per square inch.* The ratio of brightnesses between parts of the luminaire should be as small as possible. For the remainder of industrial areas it is often difficult to achieve the quality recommended for these areas. It is, however, desirable to approach them as nearly as possible particularly in areas where seeing tasks are difficult.

2.2.3.3—*Reflected Glare* — Reflected glare is caused by high brightness images, or brightness contrasts reflected from shiny ceilings, walls, desk tops, materials, and machines or surfaces within the visual field. If the seeing task is on a shiny surface or the immediate surroundings are glossy or highly-polished surfaces, reflected images of bright light sources overhead or of luminaires with excessive brightness differences will tend to veil the detail of the task. This reflected glare is frequently more annoying than direct glare because it is so close to the line of vision that the eye cannot avoid it. There are several ways in which this condition can be minimized:

(1) The brightness of the source should be as low as possible, consistent with the type of work in process and the surroundings. In the case of window areas, suitable shades can be provided. With artificial lighting, low-brightness light sources, or adequate shielding or diffusing media (or both) should be employed in the luminaires so that the brightness of reflected images is within reasonable limits.

(2) If the brightness of the light source or luminaire cannot be reduced to the desirable value, it may be possible to position either the lighting equipment or the task, so that the reflected image will be directed away from the eye of the observer.

(3) In special cases it may be practical to change the character of the offending surface to eliminate the specular reflection and the resultant reflected glare.

(4) Higher levels of general illumination will reduce the effect of reflected glare for a given image brightness because of the reduction in contrast between the reflected image and its immediate surroundings.

2.2.3.4—*Distribution, Diffusion, and Shadows*—**(a)** Evenly distributed illumination (not over 30% variation in the central area of the room) is usually desirable for industrial interiors. It permits flexible arrangement of operations and equipment and helps assure more uniform brightnesses of the entire area. Some directional and shadow effects are desirable from general illumination for accentuating the depth and form of various objects, but harsh shadows should be avoided. To achieve this result, it is essential that the lighting equipment be spaced in keeping with its light distribution characteristics and the physical characteristics of the room. Shadows are softer and less pronounced when large diffusing units are used or the object is illuminated from many sources. Where production operations are carried on close to the walls particular attention should be given to providing an adequate quantity of general illumination comparable to that in the central area.

(b) Alternate dark and light areas creating high brightness differences are undesirable because the eye has difficulty in adjusting itself for the two brightnesses and seeing becomes tiring. For this reason, purely local lighting restricted to a small work area is unsatisfactory unless there is sufficient general illumination in the room.

(c) Clearly defined shadows without excessive brightness differences are distinct aids in some specialized operations, such as engraving on polished surfaces, some types of bench layout work, and certain textile inspections. When such shadow effect is indicated, it is best obtained by supplementary directional lighting combined with diffused general illumination of ample amount.

2.2.3.5—*Color Quality of Light Source* —It appears that with equal footcandles of illumination variations in color quality of light have little or no effect upon clearness or quickness of seeing. However, in certain industries where color discrimination or color matching are highly important, the sources which provide the lighting for the matching and for the discrimination should be selected carefully. This is a matter in which the specialist should be consulted. Further discussion will be found in Section 4.3.4.6.1. Color of light does have an effect on the appearance of the room as discussed in Section 2.3.3.

*Candle per square inch is equal to 452 footlamberts.

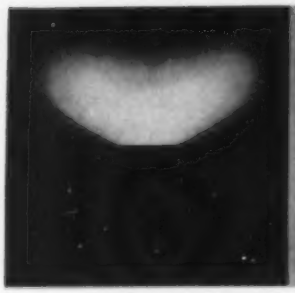


Figure 2. Indirect lighting.

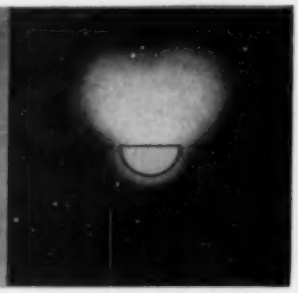
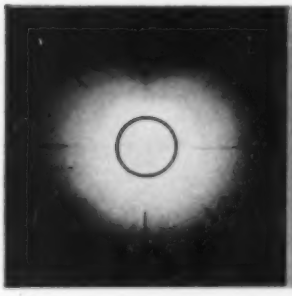


Figure 3. Semi-indirect lighting.



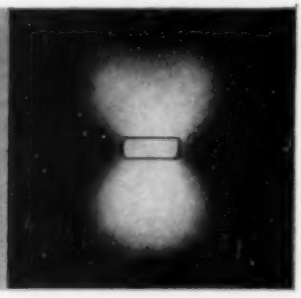


Figure 4. (a) Diffusing enclosure, (b) direct-indirect general diffuse lighting.

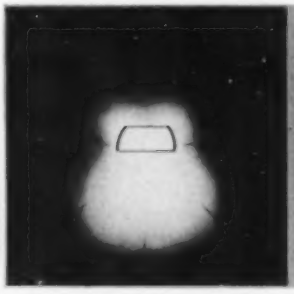


Figure 5. Semi-direct lighting.

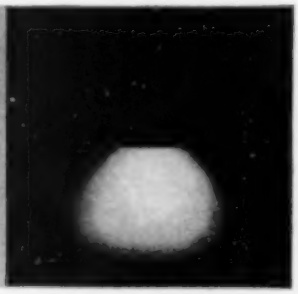


Figure 6. Direct lighting.

2.3—*Influence of Environmental Factors*

2.3.1—*Brightness and Brightness Ratios*—**(a)** The ability to see detail depends upon the brightness difference between the detail and its background. The greater the difference in brightness the more readily the seeing task is performed. However, the eyes function most comfortably and efficiently when the brightnesses within the remainder of the environment are relatively uniform. Often brightnesses within the field of view vary greatly, and all of these brightnesses contribute either favorably or unfavorably to the seeing conditions. Conclusions of the I.E.S. Committee on Standards of Quality and Quantity for Interior Illumination in regard to brightness recommendations are presented in Appendix B.

(b) The above report considers the ideal brightness relationships for the environment. In the manufacturing of certain products there are many areas where it is not practical to achieve the same brightness relationships as in light manufacturing or office areas. In the shake-out room of a foundry, for example, it is nearly impossible to have surfaces which reflect an appreciable amount of light and therefore this condition precludes the possibility of obtaining desirable brightness ratios. Between these extremes lie the bulk of industrial areas. It is always desirable to approach as nearly as possible the ideal brightness relationships. However, it has been necessary to interpret these in the light of current practicability. The values are listed in Table III.

TABLE III.—Recommended Brightness Ratios.

5 to 1	Between tasks and adjacent surroundings.
20 to 1	Between tasks and more remote surfaces.
40 to 1	Between luminaires (or sky) and surfaces adjacent to them.
80 to 1	Anywhere within the environment of the worker.

(c) From the normal point of viewing, ratios of brightness of areas of appreciable size in industrial areas should not exceed those given in Table III.

(d) These ratios are recommended as maximums; reductions are generally beneficial. It is generally desirable to have the task brighter than the surroundings.

(e) In order to achieve the recommended brightness relationships it is necessary to select the reflectances of all the finishes on room surfaces and equipment as well as control the distribution of light and the brightness characteristics of the luminaires in relationship to the particular area involved. (See 2.3.2, 2.3.3, 2.2.4.4, 4.2.)

2.3.2—*Room Finishes*—The color and the reflectance of room walls, ceiling, and floor, as well as of equipment, determines the brightness pattern and thus influences seeing as part of the environment. Recommended reflectance values are presented in Table IV.

2.3.3—*Color of Machines and Surroundings*—**(a)** Light colored surfaces are generally desirable. In addition to providing a better brightness pattern and high utilization of light, they also improve the appearance of the room. Many concerns are painting machines in such colors that they present a harmonious color picture with the interior. It appears desirable to paint stationary and moving parts of machines

TABLE IV.—Recommended Reflectance Values.

	Reflection Factor (%)
Ceiling	80
Walls	60
Desk and bench tops	35
Machines and equipment	25 to 30
Floors	not less than 15

with contrasting colors to reduce accident hazard by aiding identification.

(b) Color may be used to make the working environment more interesting and pleasant. Cream, ivory, and buff are "warm" psychologically and they tend to make a room appear smaller. On the other hand, a room may be made to appear cooler and larger by selecting "cool" colors such as green, blue-green, and blue. Warm gray finishes are closer to neutral and are excellent for either the background or for equipment and machinery. The use of gray for both, however, can be very monotonous and result in a dull and unsatisfactory environment. The color expert or the architect may wish to use stronger color to help add beauty to the interior, in which case considerable care must be exercised to assure a harmonious result that will "wear well" in an eight-hour environment.

3. Daylighting

(To be published in approved reprinted report.)

4. Artificial Lighting

4.1—*General*

(a) To maintain good seeing conditions artificial lighting must be supplied for most industrial areas as an insufficient quantity of daylight is available even under optimum daylight conditions. With natural lighting the space along the windows has the most light, while with artificial lighting this space too often has the least light. If there are benches and machines close to the windows, it is essential that the artificial lighting be so designed and installed as to continue the general level of illumination close up to the windows and walls, thus insuring good lighting over the entire working area of the room.

(b) The general lighting should be quite uniform so that the light will be available when needed at any point in the room. The manner in which the light from the lamps is controlled by the lighting equipment governs to a large extent the important effects of glare, shadows, distribution and diffusion. Luminaires are classified in accordance with the way in which they control the light, as in Figures 2 through 6. (Figs. 18-22 "Recommended Practice of Office Lighting")

Figure 7. A typical modern shop, approximately 20 x 60 feet, with a 12-foot ceiling. Two-lamp, 40-watt reflectors mounted 8-feet 6-inches above the floor in continuous rows approximately 7 feet in center, with standard cool white fluorescent lamps averaging 60 footcandles. Ceiling is white and walls are light.

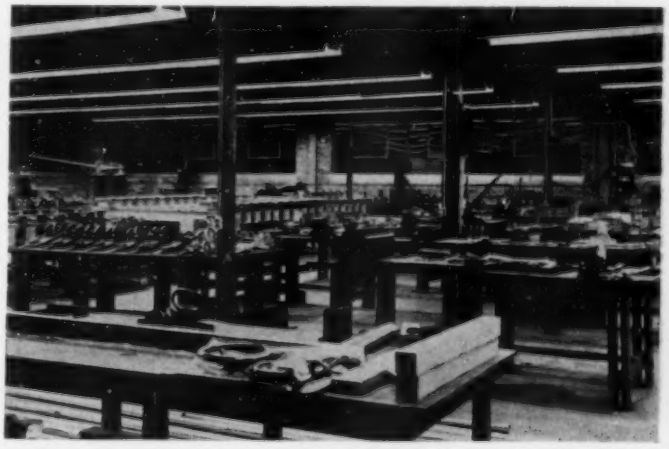


Figure 8. Assembly area, 100 x 150 feet, with 14-foot ceiling; averages 50 footcandles maintained with 3500K cold cathode fluorescent lamps in 4-lamp, 15½-inch reflectors mounted 12 feet above floor in continuous rows, on 9-foot centers.

4.2—*Lighting Systems*

4.2.1—*Direct Lighting*—**(a)** Industrial lighting is usually of the direct type. (Figures 7 and 8). Practically all of the light emitted by the luminaires (90% to 100% of total light output) is directed downward, i.e., directly toward the usual working area. While, in general, such systems provide illu-

Figure 9. Composing room receives 85 footcandles illumination from standard cool white fluorescent lamps in 2-lamp 40-watt reflectors mounted 8 feet above the floor in continuous rows 5 feet in center. Room is 25 x 80 feet with 10-foot ceiling. Ceiling and sidewalls are light in color.

mination on the working surfaces most efficiently, this may be at the expense of other factors. For example, disturbing shadows may result unless the area of the lighting units is relatively large or they are placed close together. With incandescent or mercury lamp units, shadows are at a maximum unless large-area "skylight" types of luminaires are used. The relatively large size of the fluorescent lamps tends to minimize shadows, and this is especially true when they are installed in continuous rows or in grid patterns.

(b) Glare, both direct and reflected, may be distressing. Care should be taken to select and locate the equipment to avoid exposing the worker's eyes to the glare from brilliant sources or excessive contrast between the light source and background. The latter can be reduced by illuminating the ceiling against which the lighting equipment is viewed; this also materially improves the appearance of the room.

(c) Some types of industrial equipment are designed to emit some upward light. This feature tends to brighten the ceiling and upper area of the room which tends to improve markedly the comfort of industrial interiors. The upward component is usually created by luminous sides or apertures which allow light to fall directly on the ceiling. Similar results can be achieved in either new or existing installations by utilizing separate units to illuminate the upper areas of the room. Any of these techniques help to create a more comfortable work area.

(d) Industrial lighting equipment is usually classified as "distributing" or "concentrating." The distributing types comprise porcelain-enameled reflectors and diffusers and units with various white baked-enamel and synthetic finishes. This same distribution of light can also be obtained with aluminum, mirrored-glass, prismatic-glass and similar materials with proper contour and configuration. This type of light distribution is advantageous in many industrial applications where a large proportion of the seeing tasks involve the seeing of surfaces that are vertical or nearly so.

(e) Among the concentrating, direct lighting units are the prismatic, mirrored glass and aluminum reflectors. This type of light distribution is useful when equipment for general lighting must be mounted at a height equal to or greater than the width of the room. In addition it is useful in supplementary lighting problems.

4.2.2—*Semi-Direct Lighting*—In this classification 10 to 40% of the luminaire output is directed upward and the remainder is direct lighting. The upward component reduces the brightness ratio between the luminaires and the surroundings. Luminaires of this class may be of the open-bottom type, although some have louvered or closed bottom of glass or plastic materials.

4.2.3—*General Diffuse and Direct-Indirect*—**(a)** This classification refers to systems where the predominant illumination on horizontal working surfaces comes directly from the lighting units, but where there is also a *considerable* amount (40% to 60%) of upward light from the luminaire which is reflected back from ceiling and upper wall area. Luminaires of this type are frequently found in factory offices. There are two general types of units included in this classification. The "general diffusing" distributes light about equally in all directions while the "direct-indirect" produces little light in angles near the horizontal.

(b) While general diffusing and direct-indirect lighting systems give more illumination for a specified wattage than do indirect or semi-indirect systems, shadows are more noticeable and some difficulty may be experienced with both direct and reflected glare.

4.2.4—*Semi-Indirect Lighting*—Semi-indirect lighting systems send most of their light (60% to 90% of total light output) upward and as a result a high percentage of the illumination on a horizontal plane is reflected from the ceilings and upper walls. Because the ceiling constitutes an important part of such a lighting system, careful attention must be paid to having it as light in color as possible and to maintaining it in good condition. In general, semi-indirect units produce higher illumination on work for the same wattage than do indirect units. Luminaires for semi-indirect lighting are available in completely enclosed types which reduce the collection of dust and dirt and are easily cleaned. There are also styles that are open both top and bottom so that there remains only the upper surfaces of the lamps to collect dust and dirt.

4.2.5—*Indirect Lighting*—**(a)** As the name implies, most or all of the light (90% to 100% of the total light output) from the unit is first directed to the ceiling and upper walls from which it is reflected diffusely to all parts of the room. With the ceiling becoming, in effect, the light source, the diffuse quality of the illumination minimizes shadows and reflected glare. Care must be taken to keep the apparent ceiling

Figure 10. Machine shop, approximately 50 x 60 feet in area, has 2-lamp, 40-watt reflectors mounted 8 feet above the floor in continuous rows on 10-foot centers. Cross rows are on 12-foot centers. Standard cool white fluorescent lamps provide an average of 80 footcandles illumination. The 12-foot high ceiling is white; walls, floor and machines are light in color.

Figure 11. Boiler house office uses 2-lamp 40-watt reflectors with standard cool white fluorescent lamps mounted 9 feet above floor on 8-foot centers, providing an average of 50 footcandles. Note luminous sides on reflectors.

brightness low enough to prevent its becoming a source of glare.

(b) As this lighting utilizes the ceiling as the main source of light, careful attention must be given to having it as light in color as possible and maintaining it in good condition. It should be given a flat white finish of high reflection factor.

(c) The lighting units, which may have either opaque or luminous bottoms, should be such that they can be easily cleaned, because a layer of dust and dirt absorbs a large amount of light.

4.3—*Lighting Methods for Industrial Areas*

4.3.1—*Introduction* — A mere abundance of light does not constitute good lighting. To provide satisfactory shop illumination three main conditions must be met:

(1) Quantity of illumination must be sufficient for all visual tasks (Tables I and II).

(2) Quality of lighting must be in accordance with the seeing requirement (Section 2.2.3).

(3) Lighting systems, painting of interior surfaces, machines, etc. should help provide a proper environment for the working interior (Section 2.3).

The proper method of lighting a specific area is also dependent upon the size and proportions of the room.

4.3.2—*General Lighting*

4.3.2.1—*General* — **(a)** Modern industrial lighting practice requires the establishment of a base or minimum quantity of light throughout the room. This is termed general lighting. The quantity may vary depending upon the purpose for which the space is to be used. If visual tasks are particularly severe, much higher illumination over restricted areas can be added to this base. This additional light, known as supplementary lighting, is usually provided by luminaires placed relatively close to the area being illuminated.

(b) The general lighting system usually consists of luminaires placed ten feet or more above the floor. The purpose of the general lighting system is to provide sufficient light for most seeing tasks and promote safety and plant protection.

(c) Where supplementary lighting is necessary the general lighting should keep the brightness difference between the well-lighted immediate work area and the surroundings within the ranges specified in Table III.

4.3.2.2—*Low-Bay Areas*—**(a)** In rooms relatively wide and long in proportion to the height, a distributing type of direct lighting equipment is usually applicable. (Rooms of this category have a width greater than four times the height.) Here good quality illumination is provided by fluorescent luminaires mounted in continuous rows, spaced to give the proper quantity and distribution of light (Fig. 9).

(b) The use of continuous rows of fluorescent units run at right angles, forming a grid or checkerboard pattern, provides higher levels of illumination, reduces shadows, and assures more even brightness of machine dials, regardless of the angle at which these dials may be placed (Fig. 10).

(c) If the floors and machinery are light in color they will reflect some of the light back to the ceiling. This relieves the brightness difference between the lighting equipment and its surroundings. Seeing conditions are usually improved markedly and there is also a very noticebale improvement in the appearance of the room. This is further improved if the ceiling and all equipment are painted light in color. These desirable effects can be increased by using distributing types of direct lighting equipments which are so constructed as to provide some upward light; such units approach the semi-direct classification (Fig. 11).

4.3.2.3—*High-Bay Narrow Interior*—In areas where the width is equal to or less than the height (Fig. 12), direct lighting equipment which concentrates the light is usually used in order effi-

ciently to provide the necessary illumination at the working plane. Usually incandescent or mercury vapor sources are used for this application either alone or in combination (Fig. 13). Mercury lamps have the advantage of longer life and higher efficiency. When the two types of sources are used together the filament lamps supply an excess of red light to offset the deficiency in red of the mercury, the result being a synthetic "white" widely employed for industrial areas. Also the use of combination systems alleviates the problem created by temporary power interruptions outing the mercury lamps for several minutes. Percentages of the two usually range from equal quantities of the mercury and filament light to twice as much mercury light as filament.

4.3.2.4—*High-Bay Wide Interior* — Some of the newer manufacturing areas, notably airplane assembly plants and similar spaces, are enormous in both length and width, while at the same time the ceiling height is very great, with the added requirement that there must be clear space up to 30 or 40 feet or sometimes even more. Concentrating types of direct lighting equipment can be used, mounted on appropriate spacings to provide the quantity of illumination required (Fig. 14). However, because of the extreme width and length, distributing types of direct lighting equipments can be used to good advantage with a large number

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Figure 12. (top) Press shop, 70 x 250 feet, 35 feet to bottom of trusses has 400-watt mercury reflectors with AH1 mercury lamps mounted 35 feet above floor on 14 x 14 foot centers. Illumination averages 30 footcandles.

Figure 13. (center) Machinery heavy castings room is approximately 50 x 300 feet with 35-foot ceiling height. 3000-watt mercury reflectors are mounted 35 feet above the floor on 17 x 20-foot centers. Illumination is 110 footcandles. Note: extra shielding is provided by deep trusses finished in white. Ceiling and sidewalls are white.

Figure 14. (bottom) Airplane assembly plant is illuminated by 400-watt mercury and 500-watt incandescent filament lamps alternately spaced in high-bay concentrating reflectors. Average illumination is 34 footcandles. Note the low brightness ratios inside the plant. (Photo taken from rain-covered apron outdoors.)

Figure 15. (top) Aircraft plant uses 2-lamp, 40-watt standard cool white fluorescent lamps, mounted in continuous rows 25 feet above the floor, on 13½-foot centers, through the 600 x 1000 foot area. Average illumination is 30 footcandles.

Figure 16. (center) This shipping area, approximately 30 x 30 feet, has 3-lamp louvered troughs, 7 feet in center recessed in 10-foot high ceiling. Standard cool white fluorescent lamps provide 60 footcandles.

Figure 17. (bottom) Pump room is approximately 20 x 25 feet with an 11-foot ceiling. Two-lamp, 96T12 reflectors are mounted 8 feet above floor in continuous rows, 8 feet on centers, with standard cool white fluorescent lamps providing 40 footcandles. Note white ceiling. Upward light and light finishes are used throughout including the machinery.

of luminaires each contributing a small amount of light to any given point. This reduces shadows to a minimum and gives higher vertical surface illumination. With fluorescent units the effect approaches that of indirect lighting. These fluorescent luminaires are preferably mounted in continuous rows, which simplifies installation and wiring (Fig. 15). Various means have been used to suspend the rows and maintain a straight, neat appearance; one example is a system of messenger cables with supporting cables or rods hung at intervals from the ceiling.

4.3.2.5—*Non-productive and Service Areas*—In areas where work is primarily of a non-productive nature, such as warehousing, boiler and pump rooms, freight elevators, washrooms, lockers, corridors . . . etc., the lighting requirement is usually one of providing reasonable diffusion, comfort, and appearance with a minimum of cost (Figures 16 and 17). For these types of areas where but little light (5 to 10 footcandles) is necessary, the requirements can be met with incandescent lamps in direct (distributing) equipment or in semi-direct units. Where better appearance is a factor or where a higher level of illumination is necessary, or both, as in active warehousing, packing of small articles or for export . . . etc., it is desirable to use direct or semi-direct fluorescent equipment. For example, in a warehouse where the work approaches continuous-line operation, continuous rows of fluorescent

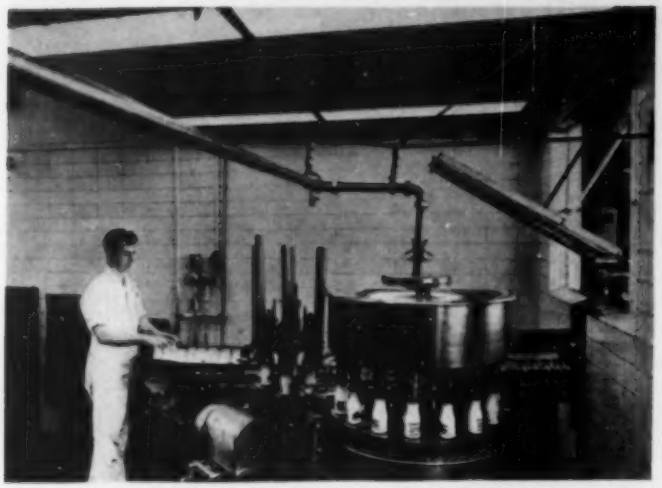


Figure 18. An example of localized general lighting in bottling area of a dairy uses 2-lamp, 40-watt vaporproof reflectors. 3500K fluorescent lamps are used in four units on 5 x 40 foot centers and provide 55 footcandles illumination.

reflectors of the direct type can be mounted over the work areas with good results.

4.3.3—*Localized General Lighting* — Many industrial plants have machinery of such a nature and so located that a uniform intensity of illumination is not necessary throughout the area. Luminaires may be mounted above the visual task, supplying adequate levels of illumination at the particular work points and at the same time providing sufficient illumination for adjacent areas. Fig. 18 shows an example of localized general lighting.

4.3.4—*Supplementary Lighting**

4.3.4.1—*General*—(a) Difficult seeing tasks often require a specific amount of quality of lighting which cannot readily be obtained by standard general lighting methods. To solve such problems supplementary luminaires often are used to provide high illumination levels for small or restricted areas. Also, they are used to furnish a certain brightness, or color, or to permit special aiming or positioning of light sources to avoid shadows caused by workmen or machinery.

(b) Before supplementary lighting can be specified it is necessary to recognize the exact nature of the visual task that is difficult to see and to understand its light reflecting or transmitting characteristics. An improvement in the visibility of the task will depend upon one or more of the four fundamental visibility factors—brightness, contrast, size and time. Thus, in analyzing the problem, the engineer may find that seeing difficulty is caused by insufficient brightness, poor contrast, small size, or task motion is too fast for existing seeing conditions.

(c) The planning of supplementary lighting also entails consideration of the visual comfort of both those who benefit directly, and the other workers in the immediate area. Supplementary equipment must be carefully shielded to prevent glare for the user and his associates. Brightness ratios should be carefully controlled, for a worker may frequently glance away from a critical task for relaxation and he should not be forced to encounter extreme brightness differences from the brightness of the task. Ratios between task and immediate surroundings should be limited as recommended in Section 2.3.1. To attain these limits, it is necessary to coordinate the design of supplementary and general lighting.

4.3.4.2—*Luminaires for Supplementary Lighting* — Supplementary lighting units can be divided into five major types according to candlepower distribution and brightness. These are:

Type S-I—The directional type includes all concentrating units. Examples are a reflector spot-lamp and concentrating reflectors or lenses. Also included in the group are concentrating longitudinal units such as a well-shielded fluorescent lamp in a concentrating reflector.

Type S-II—The spread, high brightness type includes all units having a maximum brightness of over 4000 footlamberts. A deep bowl reflector with a filament lamp and without diffusing cover is an example of this type.

Type S-III — The spread, moderate brightness type includes all units having a maximum brightness of less than 4000 footlamberts and with a variation in brightness of more than 2 to 1. A direct fluorescent luminaire is an example of this type.

Type S-IV—The uniform brightness type includes all units having less than 2 to 1 variation of brightness. An example of this type is an arrangement of lamps behind a diffusing panel.

Type S-V—The uniform brightness type with a pattern is a luminaire similar to Type IV except a pattern of stripes or lines is super-imposed on the uniform, low brightness area of the unit.

4.3.4.3—*Portable Luminaires* — Wherever possible supplementary luminaires should be permanently mounted in the location to produce the best over-all effect. Adjustable arms and swivels will often adapt the luminaires to required flexibility. Portable equipment, however, can be used to good advantage in airplane assembly, garages or where internal surfaces must be viewed. The luminaires must be mechanically and electrically rugged to withstand possible rough handling. Lamps should be guarded and of the rough-service type. Guards or other means should protect the user from excessive heat. All possible precautions should be taken to prevent electrical shock to the user. Care should be taken to avoid direct glare resulting from misplacement or misaiming of portable luminaires.

4.3.4.4—*Illumination of Difficult Seeing Tasks* — The following chart has been developed to serve as a guide in applying the proper luminaire types to tasks with various characteristics. The actual problem may involve more

*Selected copy and illustrations from forthcoming report of the Supplementary Lighting Committee, to be published.

than one seeing task and therefore combined lighting techniques are required.

4.3.4.5—*Classification of Visual Tasks and Lighting Techniques*—Visual tasks are unlimited in number but can be classified according to certain common characteristics. The detail to be seen in each group can be emphasized by an application of certain lighting fundamentals. Table IV classifies tasks according to their physical and light controlling characteristics and suggests lighting techniques for good visual perception.

It should be noted when using this table that the classification of visual tasks is based on the prime and fundamental visual task characteristics and not on the general application. For example, on a drill press the visual task would be the discernment of a punch mark on metal. This could be specular detail with a diffuse, dark background, classification A-3(b) in the table. Luminaire types S-II or S-III are recommended. S-II on an adjustable arm-bracket is a practical recommendation due to space limitations.

4.3.4.6—*Special Effects and Techniques*

4.3.4.6.1—*Color*—**(a)** Color as a part of the seeing task can be very effectively used to improve contrast. While black and white are the most desirable combinations for such continual tasks as the reading of a book, it has been found that certain color combinations have a greater attention value. It has been shown that black on yellow is most legible and the next combinations in order of preference are green on white, red on white, blue on white, white on blue, and finally black on white.

(b) The color of light can be used to increase contrast by either intensifying or subduing certain colors inherent in the seeing task. To intensify a color, the light source should be strong in

Figure 19. Strain gauge area, 13 by 25 feet with 10-foot 6-inch ceiling height utilizes general lighting of standard cool white fluorescent lamps in 2-lamp, 40-watt reflectors mounted 9 feet above floor in continuous rows on 7-foot centers to achieve 60 footcandles. Supplementary lighting consists of 2-lamp, 40-watt reflectors adjusted in height to approximately two feet above tables. Average illumination is 150 footcandles.

Figure 20. Cafeteria has 2-lamp, 40-watt troffers, 8 x 10 feet on centers recessed in 8-foot high ceiling. Standard cool white fluorescent lamps provide 25 footcandles. Additional illumination is supplied over serving areas.

Figure 21. Dispensary uses standard cool white fluorescent lamps in 2-lamp, 40-watt troughs, recessed in continuous rows, 3 feet on centers, in 9-foot high ceiling. Illumination is 80 footcandles.

this color and to subdue a color the source should have relatively low output in the particular color. For example, it has been found that chromium plating imperfections over nickel plating can be emphasized by using a bluish color of light such as the daylight fluorescent lamp.

4.3.4.6.2—*Three dimensional objects* are seen in their apparent shapes because of the shadows and highlights resulting from certain directional components of light. This directional effect is particularly useful in emphasizing texture and defects on uneven surfaces.

4.3.4.6.3—*Silhouette* is an effective means of checking contour with a standard template. Illumination be-

TABLE IV.—Classification of Visual Tasks and Lighting Techniques.

PART I—FLAT SURFACES

Classification of Visual Task	Example		Lighting Technique	
General Characteristics	Description	Lighting Requirements	Luminaire Type	Locate Luminaire
A. Opaque Materials				
1. Diffuse detail & background				
a. Unbroken surface	Newspaper proof reading	High visibility with comfort	S-III or S-II	To prevent direct glare & shadows
b. Broken surface	Scratch on unglazed tile	To emphasize surface break	S-I	To direct light obliquely to surface
2. Specular detail & background				
a. Unbroken surface	Dent, warps, uneven surface	Emphasize unevenness	S-V	So that image of source & pattern is reflected to eye
b. Broken surface	Scratch, scribe, engraving, punch marks	Create contrast of cut against specular surface	S-III	So detail appears bright against a dark background
			or S-IV or V when not practical to orient task	So that image of source is reflected to eye & break appears dark
c. Specular coating over specular background	Inspection of finish plating over under plating	To show up uncovered spots	S-IV with color of source selected to create maximum color contrast between two coatings	For reflection of source image toward the eye
3. Combined specular & diffuse surfaces				
a. Specular detail on diffuse, light background	Shiny ink or pencil marks on dull paper	To produce maximum contrast without reflected glare from shiny markings	S-III or S-IV	So direction of reflected light does not coincide with angle of view
b. Specular detail on diffuse, dark background	Punch or scribe marks on dull metal	To create bright reflection from detail	S-II or S-III	So direction of reflected light from detail coincides with angle of view
c. Diffuse detail on specular, light background	Graduations on a steel scale	To create a uniform, low brightness reflection from specular background	S-IV or S-III	So reflected image of source coincides with angle of view
d. Diffuse detail on specular, dark background	Wax marks on auto body	To produce high brightness of detail against dark background	S-III or S-II	So direction of reflected light does not coincide with angle of view
B. Translucent Materials				
1. With diffuse surface	Frosted or etched glass or plastic, light weight fabrics, hosiery	Maximum visibility of surface detail	Treat as opaque, diffuse surface—See A-1	
		Maximum visibility of detail within material	Trans-illuminate behind material with S-II, S-III or S-IV	
2. With specular surface	Scratch on opal glass or plastic	Maximum visibility of surface detail	Treat as opaque, specular surface—See A-2	
		Maximum visibility of detail within material	Trans-illuminate behind material with S-II, S-III or S-IV	
C. Transparent Materials				
Clear material with specular surface	Plate glass	To produce visibility of details within material such as bubbles & details on surface such as scratches	S-V and S-I	Transparent material should move in front of Type S-V, then in front of black background with Type S-I directed obliquely. Type S-I should be directed to prevent reflected glare.
D. Transparent over Opaque Materials				
1. Transparent material over diffuse background	Instrument panel	Maximum visibility of scale & pointer without reflected glare	S-I	So reflection of source does not coincide with angle of view
	Varnished desk top	Maximum visibility of detail on or in transparent coating or on diffuse background		
		Emphasis of uneven surface	S-V	So that image of source & pattern is reflected to the eye
2. Transparent material over specular background	Glass mirror	Maximum visibility of detail on or in transparent material	S-I	So reflection of source does not coincide with angle of view. Mirror should reflect a black background
		Maximum visibility of detail on specular background	S-V	So that image of source & pattern is reflected to the eye

PART II — THREE DIMENSIONAL OBJECTS

Classification of Visual Task	Example		Lighting Technique	
General Characteristics	Description	Lighting Requirements	Luminaire Type	Locate Luminaire
A. Opaque Materials				
1. Diffuse detail & background	Dirt on a casting or blow holes in a casting	To emphasize detail with a poor contrast	S-III or S-II or	To prevent direct glare & shadows
			S-I or	In relation to task to emphasize detail by means of highlight & shadow
			S-III or S-II as a black light source when object has a fluorescent coating	To direct ultra-violet radiation to all points to be checked
2. Specular detail & background				
a. Detail on the surface	Dent on silverware	To emphasize surface unevenness	S-V	To reflect image of source to eye
	Inspection of finish plating over under plating	To show up areas not properly plated	S-IV plus proper color	To reflect image of source to eye
b. Detail in the surface	Scratch on a watch case	To emphasize surface break	S-IV	To reflect image of source to eye
3. Combination specular & diffuse				
a. Specular detail on diffuse background	Coal picking	To make coal glitter in contrast to dull impurities	S-II	To prevent direct glare
	Scribe mark on casting		S-III or S-II	In relation to task for best visibility. Adjustable equipment often helpful
b. Diffuse detail on specular background	Micrometer scale	To create luminous background against which scale markings can be seen in high contrast	S-IV or	Overhead to reflect image of source to eye
			S-III	With axis normal to axis of micrometer
B. Translucent Materials				
1. Diffuse surface	Lamp shade	To show imperfections in material	S-II	Behind or within for trans-illumination
2. Specular surface	Glass enclosing globe	To emphasize surface irregularities	S-V	Overhead to reflect image of source to eye
		To check homogeniety	S-II	Behind or within for trans-illumination
C. Transparent Materials				
Clear material with specular surface	Bottles, glassware—empty or filled with clear liquid	To emphasize surface irregularities	S-I	To be directed obliquely to objects
		To emphasize cracks, chips & foreign particles	S-IV or S-V	Behind for trans-illumination. Motion of objects is helpful.

hind the template will show brightness where there is a difference between the contour of the standard and the object to be checked.

4.3.4.6.4—*Fluorescence under ultra-violet* radiation is often useful in creating contrast Surface flaws in metal and non-porous plastic and ceramic parts can be detected by the use of fluorescent materials.

4.3.4.6.5—*Polarized illumination*—The detection of internal strains in glass, mounted lenses, lamp bulbs, radio tubes, transparent plastics, etc. may be facilitated by transmitted polarized light. The nonuniform spectral transmittance of strained areas causes the formation of color fringes that are visible to an inspector. With transparent models of structures and machine parts, it is possible to analyze strains under operating conditions.

4.3.4.6.6—*Minute details and high precision* — Careful inspection of very small objects may be greatly simplified by viewing through magnified images. For production work the magnified image may be projected on a screen. Because the projected silhouette is many times the actual size of the object, any irregular shapes or improper spacings can be detected readily. Similar devices are employed for the inspection of machine parts where accurate dimensions and contours are essential. One typical device now in common use projects an enlarged silhouette of the teeth on a profile chart. The meshing of these production gears with a perfectly cut standard is examined on the chart.

4.3.4.6.7—*Moving parts* — It is sometimes necessary to inspect and study moving parts while they are operating. This can be done with stroboscopic illumination which can be adjusted to "stop" or "slow up" the motion of constant speed rotating and reciprocating machinery. Stroboscopic lamps give flashes of light at controllable intervals (frequencies). Their flashing can be so timed that when the flash occurs, an object with rotating or reciprocating motion is always in exactly the same position and appears to stand still.

A draft of this proposed report is now before the American Standards Association for its consideration and possible development into an approved American Standard. Pending such approval, reprints of the proposed revision as published here will not be available.

Guard, in shadow at left, can easily see intruder although he himself is unable to be observed.

Area Protection Lighting for Industry

Probably as much as seventy per cent of all sabotage — whether by alien agents, strikers or carelessness — is attempted during the hours of darkness. The reason is obvious. Darkness favors the intruder and hampers the guard. To aid in the design of effective protective lighting systems, the I.E.S. Committee on Protective Lighting has prepared the following recommendations, based on studies undertaken for the forthcoming revision of the I.E.S. Lighting Handbook.

Isolated fenced boundary using Type I streetlighting type luminaire (left).

PROTECTIVE lighting is intended to facilitate the nighttime policing of industrial and other properties. It may also reduce fire risk. Illumination for outdoor work at night is in addition to that provided for protection.

Two basic systems or a combination of both may be used to provide a practical and effective solution. The first method is to light the boundaries and approaches. The second method is to light the area and structures within the general boundaries of the property.

Searchlights operated by guards should be employed with either system to permit supplementary illumination of areas temporarily under suspicion.

Protective lighting, to be effective, should:

1. Discourage or deter attempts at entry by intruders. Proper illumination may lead a potential

intruder to believe detection inevitable. However, lighting should not be used alone. It should be employed with other measures such as fixed or patrolling guards, fences, alarms, etc.

2. Make detection certain should entry be effected.

3. Avoid glare that handicaps the guards. Glare directed at the intruder, if not in violation of the above, is effective in annoying the intruder and preventing the discovery of the guard.

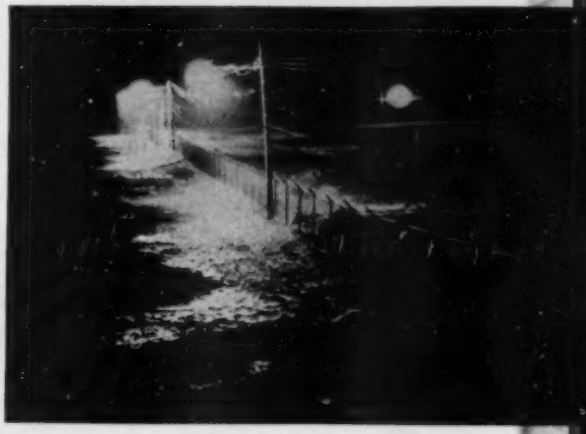
4. Provide complete reliability. Failure of a single lamp should not leave a dark spot vulnerable to entry.

5. Provide special treatment for such situations as railroad sidings, alleys, roofs of butting buildings, wooded or water approaches, entrances and exits.

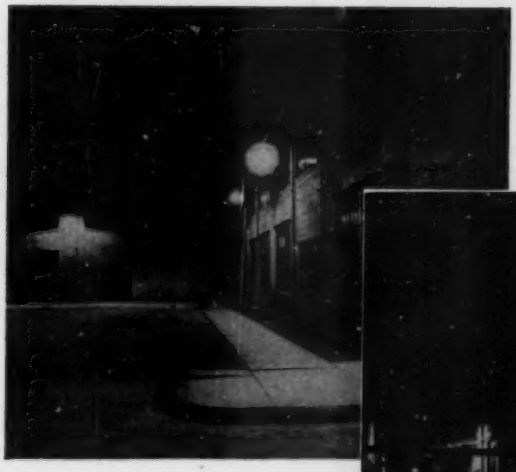
6. Provide adequate illumination. The amount of light required depends upon the accessibility and vulnerability of the property.

Protective Lighting Equipment

Protective lighting employs the conventional types of street lighting luminaires, floodlights and reflectorized lamps, together with Fresnel lens lan-



Isolated fenced boundary using Fresnel type luminaire in glare projection technique.



(Above) Two views showing isolated fenced boundary using Type II streetlighting type luminaires. (Left and below) Area lighting within plant by streetlighting type luminaires.

terns and searchlights. The choice in type of equipment depends upon the pattern of light required, considerations of glare, convenience in servicing, and the mechanical construction. The permissible locations of the equipment to insure freedom from malicious damage frequently indicates the type of luminaire best suited to conditions.

Street Lighting Luminaires

Enclosed and open types of suspension street lighting luminaires find application in protective lighting in both the symmetrical and asymmetrical distributions, and operated from series and multiple circuits. References to streetlighting luminaires herein is in accordance with the "American Standard Practice for Street and Highway Lighting" classifications.

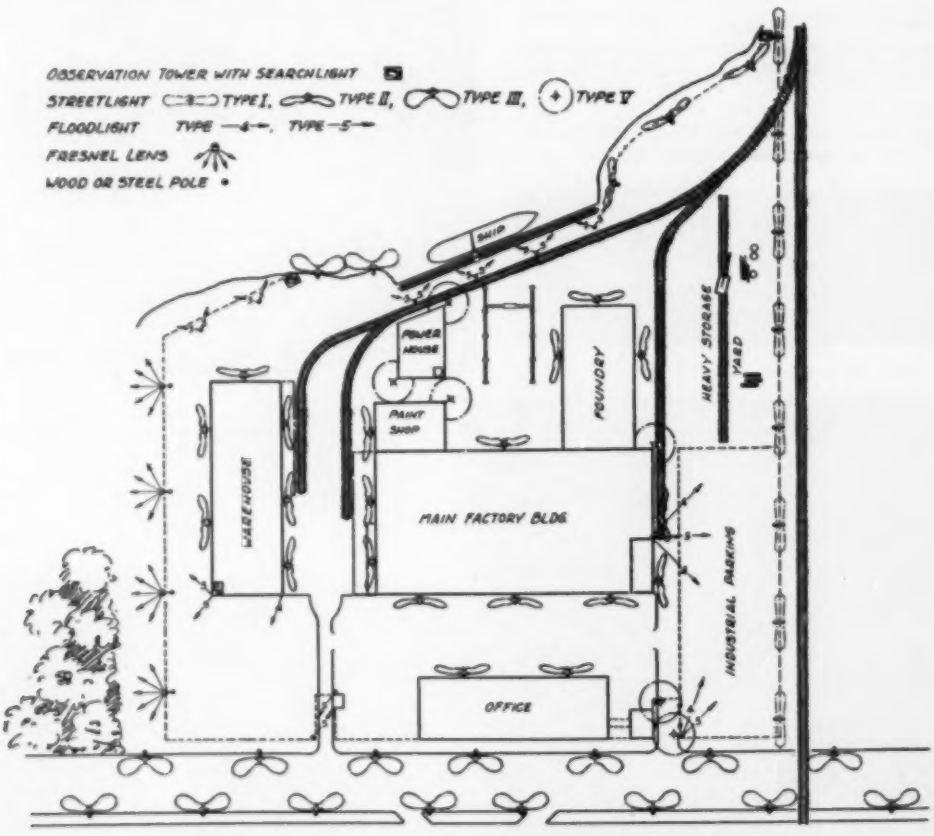
TABLE I.—Current Recommended Practice for Protective Lighting.

Location	Average* Footcandles*
Boundaries	
Glare projection technique (isolated)	.15 vertical
General lighting technique (non-isolated)	.2
Entrances	
Active (Pedestrian and/or conveyance)	2.0
Inactive (Normally locked, infrequently used)	.5
Vital locations or structures	2.0**
Building surrounds	.5
Active shipping area surrounds	2.0
General inactive areas	.2

*Horizontal unless otherwise noted.
**Should not fall below this value at any point.

Floodlights

Floodlights are used for emphasizing definite areas or where it is desired to locate the lighting unit in an inaccessible location, and project the light to the critical area. The floodlight may also

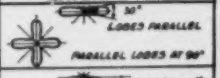
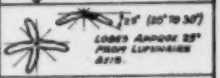
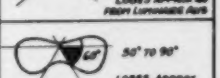
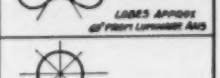
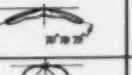
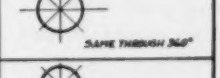
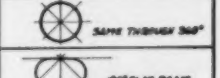
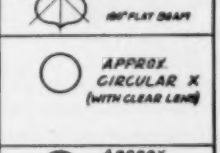
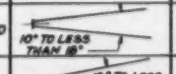
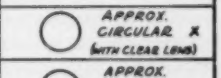
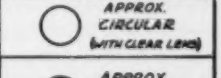
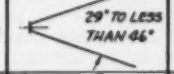
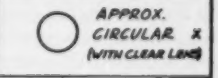
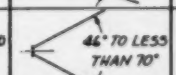
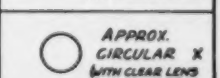
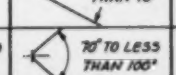
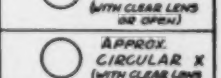
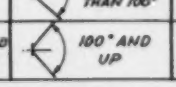
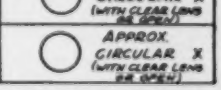


Typical plant layout using various types of protective lighting equipment.

be used for fence lighting, or general area lighting. Reflectorized lamps may be used for such applications as small areas, irregular spaces and local lighting.

Floodlights are commonly operated from a multiple circuit. An isolating transformer may be used for operating floodlights from a series circuit, if circumstances make this necessary.

TYPICAL EQUIPMENT FOR PROTECTIVE LIGHTING

LUMINAIRE		TYPE	PHOTOMETRIC DESIGNATION	OPEN OR ENCLOSED	TYPICAL DISTRIBUTION CHARACTERISTICS	
					VERTICAL	LATERAL
STREETLIGHT		I	TWO-WAY FOUR-WAY	ENCLOSED		
STREETLIGHT		II	NARROW ASYMMETRIC FOUR-WAY	ENCLOSED		
STREETLIGHT		III	MEDIUM WIDE ASYMMETRIC	ENCLOSED		
STREETLIGHT		IV	WIDE ASYMMETRIC	ENCLOSED		
STREETLIGHT		V	SYMMETRIC	ENCLOSED		
REFLECTOR		ASYMMETRIC OR SYMMETRIC	ASYMMETRIC OR SYMMETRIC	OPEN		
FRESNEL LENS		GLARE PROJECTION	ASYMMETRIC	ENCLOSED		
SEARCHLIGHT			EXTREMELY NARROW BEAM	ENCLOSED		
FLOODLIGHT		1	VERY NARROW BEAM	ENCLOSED		
FLOODLIGHT		2	NARROW BEAM	ENCLOSED		
FLOODLIGHT		3	MEDIUM BEAM	ENCLOSED		
FLOODLIGHT		4	MEDIUM WIDE BEAM	ENCLOSED OR OPEN		
FLOODLIGHT		5	WIDE BEAM	ENCLOSED OR OPEN		
FLOODLIGHT		6	VERY WIDE BEAM	ENCLOSED OR OPEN		

X NOTE: IF A SPREAD LENS IS USED THE VERTICAL SPREAD WILL REMAIN APPROXIMATELY THE SAME, WHILE THE HORIZONTAL BEAM WILL BE WIDENED CONSIDERABLY.

STREET LIGHTING LUMINAIRES ARE TYPICAL ACCORDING TO IES DESIGNATION.

FLOODLIGHTING LUMINAIRES ARE TYPICAL ACCORDING TO NEMA AND IES DESIGNATION.

REFLECTORIZED LAMPS FALL INTO FLOODLIGHT STREET LIGHTING CLASSIFICATIONS ACCORDING TO THEIR DISTRIBUTIONS.

Table II — Typical Boundary Lighting Applications

Application	Luminaire Type & Class	Luminaire Location Feet inside Boundary	Minimum Mounting Height (feet)	Spacing*
Isolated Fenced Boundaries	Fresnel	10-15	16-20	150-175
	Streetlight I or II	10-15	25	150-175
Non-Isolated Fenced Boundaries	Streetlight I, II or III	10-15	25	150-175
	Floodlight 3 or 4	20-30 2 per location	35-40	350-400
Boundaries Formed by Buildings	Floodlight 5	1 per location on building	25	150-175
	Streetlight I, II or III	bracket on building	25	150-175
Active Pedestrian Entrance	Streetlight V	2 separate locations	20-25	**
	Floodlight 5	2 separate locations	25-30	**
Inactive Conveyance Entrance	Floodlight 5	2 separate locations	25-30	**
	Streetlight I, II or III	10 or less	25	150-175
Water Fronts	Floodlights 3 or 5	2 per location	30	200-250

(Location of waterfront units shall be such that no appreciable shadow shall be thrown on the water by sea-wall or bank. Coast Guard officials shall be consulted for approval of any proposed lighting adjacent to navigable waters.)

*Calculations based on 300-watt lamps. Other sizes and corresponding spacing may provide an equally good or better installation.

**Luminaires at constantly attended entrances may be mounted at or even outside the boundaries.

The classification of floodlights used in this chapter is that established by the I.E.S. and NEMA.

Fresnel Lanterns

The Fresnel lens lantern as used in protective lighting is a half cylindrical lens delivering a narrow fan of light through a horizontal angle of 180 degrees, and a vertical angle of 15 to 30 degrees. It is used primarily to illuminate the approaches to a property, by directing the light outward to illuminate the approaches and inflict glare on the would-be intruder while affording the guard comparative concealment in darkness. Its application is limited to locations where the glare will not be a source of disturbance to others.

Searchlights

Searchlights used for protective lighting are usually of the incandescent type because these require a minimum of attention and are easily operated and dependable. Searchlights are rated in diameter of reflector and lamp wattage, and for protective lighting service fall within the range of 12" to 24" and 250 to 3000 watts. In protective lighting the pilot house control finds greatest application as the searchlight may be located on the roof of the guard house and the maneuvering controls carried down into the guard room. Searchlights installed in this manner permit the guard to investigate suspicious actions and explore unlighted areas periodically.

Photo Credits in this Issue

Allis-Chalmers, p. 263; Anaconda Wire and Cable Company, p. 223; The Austin Company, p. 223; Boeing Airplane Company, p. 223; General Electric Company, p. 266, 267; Landis Tool Company, top, p. 260; New York Central Railroad, p. 223; Standard Oil Company (N. J.), p. 223; United States Rubber Company, p. 223; United States Steel Corporation, p. 223; Western Electric Company, Figure 1, p. 256.

Relighting a Factory

To Present-Day Standards

Outside view shows difference between relighted first floor and the second floor which is yet to be done

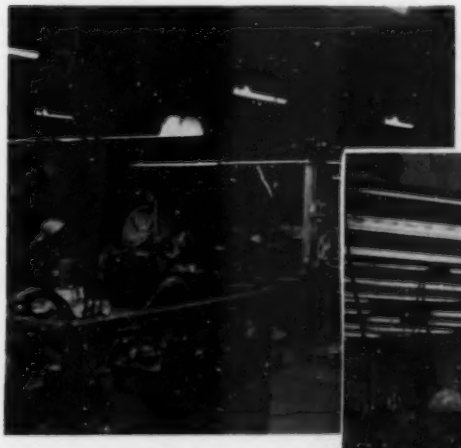
By G. E. PIEPER

THE LIGHTING program of the Metals and Controls Corporation plant in Attleboro, Mass., was started in May 1950 with two objectives in mind:

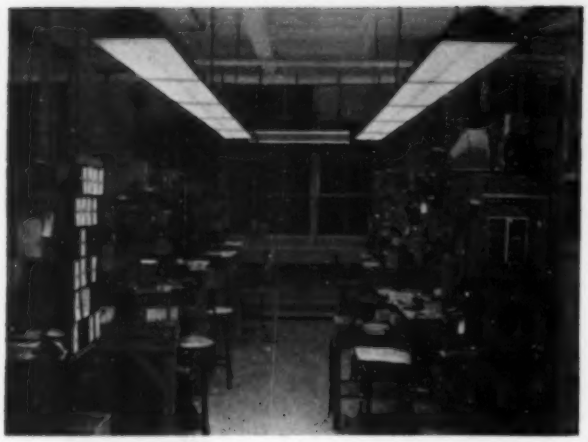
1. To bring lighting in the factory up to present day standards both in quality and quantity.
2. To standardize on a luminaire and general layout that would be flexible enough to be increased at a later date without too much work.

Author: Material Engineer, Spencer Thermostat Division, Metals & Controls Corp., Attleboro, Mass.

The first objective was accomplished by using a luminaire originally designed for school and office lighting. The unit gives about 40 per cent upward component of light and 60 per cent downward component. The bottom is louvered to give maximum shielding which is necessary whenever an intensity above 35 footcandles is used. In many cases the



Production area (left) has not yet been relighted. Typical production area (below) after relighting, uses light finishes throughout and equipment chosen to provide considerable upward light and shielding of lamps. Ceiling is white; walls, light green; machines light green. Illumination level is approximately 75 footcandles.



In this section of the welding department, 75 footcandles illumination and light finishes throughout the room improve seeing conditions for efficient high quality work. Note effect of upward light.

seeing task is moderately severe as, for example, when screw sizes of 4-56 and 2-64 are used. Most products, when completely assembled are no more than 1¼ inches in diameter.

The second objective was accomplished by installing rows of luminaires either 5 feet or 7 feet apart, depending on the department and existing conditions. Where continuous rows were not needed, a space of 4 feet was left between units for further expansion.

The minimum intensity of any department is 35 footcandles maintained. The maximum is 75 footcandles maintained.

The luminaires were hung on adjustable hanger channel. This was used so that hangers could be hung from "I" beams usually 7 feet apart, but in some cases as much as 12 feet apart. By using adjustable channel, the rows were straighter and it was possible to avoid overhead piping by moving a hanger, something that would not be possible with individual hangers.

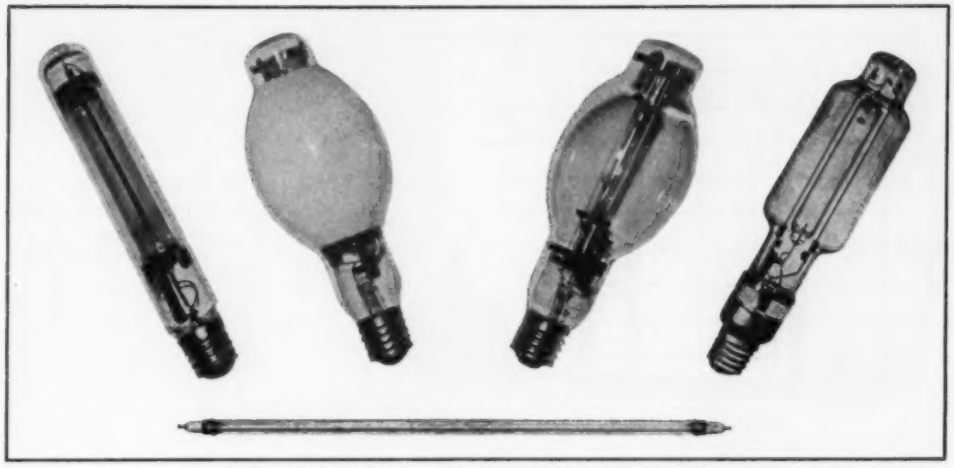
The ceiling and all overhead piping were painted white. Overhead pipes, contrary to expectation, do not appear objectionable, and the general effect is that of a spacious room. The ceiling is up where it belongs and not down at the fixture level.

The old type and the new type of installation are shown on the previous page. The light intensities in the photographs are approximately the same on the working plane; the major change is the quality.

The photos below show a lighting installation for a department other than the one shown here which is only temporarily occupying this space. The two long lines of luminaires will shed light over the two rows of tool-makers' benches set 90 degrees from the direction of the units. The aisle will be wider and some temporary wiring will be removed.

In all, there are more than 1000 of these luminaires being used in production areas, and the results have been very satisfactory. The lamp used is standard cool white.

Temporary set-ups while permanent location of this department is being relighted in a similar manner.



Left to right, A-H1, J-H1, E-H1 and A-H12. Across bottom, A-H9.

Which Mercury Lamp is Best ?

By W. S. TILL and J. R. JONES

No one lamp is best for all applications. Lamp choice should be based on an analysis of each specific application.

NEW ADDITIONS to the mercury line and new developments in existing lamps have made it necessary to reappraise the various mercury sources for industrial lighting. Recent developments in these sources, including color correction and high efficiency, now permit their use in installations where previously filament and fluorescent sources only, were practicable.

A-H1

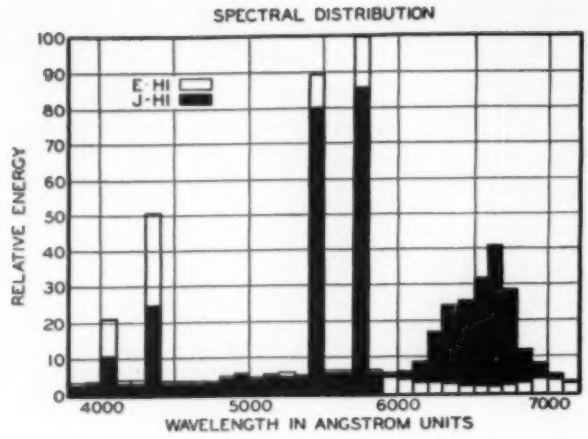
The A-H1, introduced in 1934, has been the most widely used mercury lamp for industrial lighting. The open aluminum type of luminaire and the enclosed heavy duty in wide, medium or spread distributions, and the 400-watt dome have been widely used for its application. In locations where the atmosphere contains large amounts of smoke or dirt, the enclosed type is usually applicable. The dome is usually used for low mounting heights. The dome has a glass diffusing ring to shield the bright arc from most viewing positions. Past practice has been to use 750-watt filament lamps in alternate fixtures in an installation to provide color correction. Current practice is to install mercury and filament lamps in an equal wattage basis. In some cases filament lamps have been used only to provide low levels of illumination, while the mercury lamps are warming up, or are omitted completely. Compared to filament lamps the A-H1 is a highly efficient light source producing almost twice as many lumens per watt as the 750-watt incandescent lamp. This is low compared to newer mercury lamps, but for several years the A-H1 was the most economical source for many applications. Recent improvements in existing lamps and some newer mercury sources indicate that other mercury lamps, the E-H1 and the A-H12 especially, will be used more in the future than the A-H1.

Authors: Westinghouse Electric Corp., Bloomfield, N. J.

E-H1

The E-H1, a quartz arc tube lamp developed within the last ten years, is one of the new lamps that will replace the A-H1 is many lighting installations.

Although the E-H1 was developed primarily as a lamp for street lighting, it is the 400-watt source of the future. It is superior to the older A-H1 in many respects, producing a third more light with the same wattage and is better adapted to control, as in a narrow beam reflector. The starting and



The large black area at the right represents the energy emitted by the J-H1 in the red region.

restriking time is only four minutes compared to seven for the A-H1, hence the delay caused by temporary power failure is appreciably shorter. The E-H1 can burn in any position, whereas the A-H1 is generally restricted to vertical burning.

From an economy standpoint, the high efficiency of the E-H1 makes it definitely superior to any other 400-watt mercury lamp. For mounting heights from 18 to about 35 feet, the E-H1 is more economical than any other light source available for industrial lighting. At higher mounting heights, one of the higher wattage sources is more economical.

Existing 400-watt mercury lighting equipment was designed originally for the A-H1; however, most reflectors are equally suitable for the E-H1. The effect on the distribution curve, of substituting the E-H1 for the A-H1, is small for most fixtures, although the maximum candlepower is slightly greater. Only with the 400-watt dome does it change the distribution appreciably. With this luminaire the maximum candlepower is almost double the candlepower at about 10 degrees off the axis of the beam. This would mean that the footcandles directly under the luminaire would be almost double the footcandles a few feet away. Also, the diffusing ring that is now located in such a position as to provide shielding for the arc of the A-H1 would have to be set further up into the neck of the reflector to shield the E-H1 properly. This minor modification is necessary because both the light center length and the arc length of the E-H1 are shorter than for the A-H1.

The New J-H1

One of the most interesting new developments in mercury lamps is the 400-watt J-H1 color-corrected lamp. A practical improvement in the color of mercury light is produced with little sacrifice in efficiency.

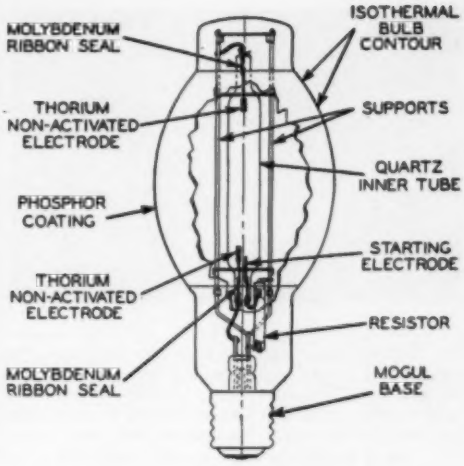
By means of an unusual phosphor coating on the J-H1 bulb wall, red light ordinarily lacking in mercury lamps is produced and blended with the light of the arc stream, making "white" light that is far superior to the standard bluish mercury light. High efficiency is possible because the phos-

TABLE I.

	A-H1	J-H1	E-H1	A-H12	A-H9
Lamp Watts	400	400	400	1000	3000
Initial Lumens	15,000	18,000	20,000	57,000	120,000
Lumens per Watt (Inc. ballast loss)	34	41	45½	52½	38
Rated Average Life	4,000 Hrs.[1] 6,000 Hrs.[2]	4,000 Hrs.	5,000 Hrs.	4,000 Hrs.	6,000 Hrs.[2] 10,000 Hrs.[3]
Warmup Time	7 Min.	4 Min.	4 Min.	4 Min.	7 Min.
Restriking Time	7 Min.	4 Min.	4 Min.	6 Min.	8 Min.
Arc Length	6"	2⅝"	2⅝"	5"	48"
Over-all Length	13"	11"	11"	14"	54⅝"
Arc Tube Material	Glass	Quartz	Quartz	Quartz	Glass
Burning Position	Restricted	Any	Any	Any	Any
List Price	$10.50	$30.00	$17.00	$50.00	$48.00

[1]At 5 hours' burning per start.
[2]At 10 hours' burning per start.
[3]At 144 hours' burning per start.

Replacing A-H1 with J-H1 (above) raises the illumination level and provides color correction. Note glass diffusing ring has been removed. (Right) the new J-H1.



J-H1 COLOR CORRECTED MERCURY VAPOR LAMP

phor converts into visible red light the ordinarily wasted invisible ultraviolet energy, which constitutes over 50 per cent of total lamp energy up through the visible region. The isothermal bulb shape was carefully chosen to keep the phosphor at the best operating temperature.

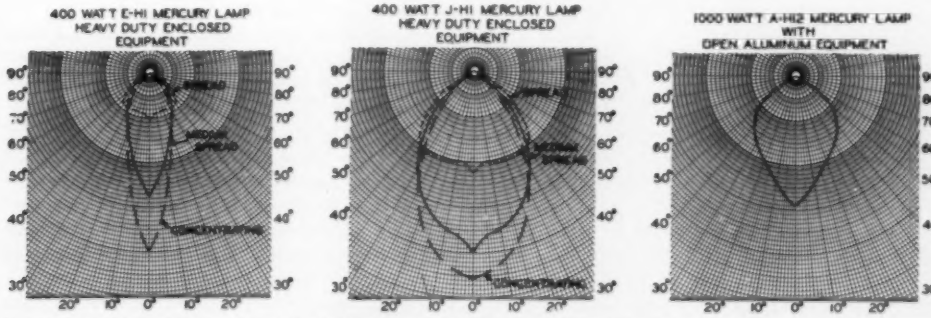
The JH-1 has a tentative initial rating of 18,000 lumens, which compares with 20,000 for the 400-watt E-H1 and 15,000 for the 400-watt A-H1.

The history of new lamp developments shows that lamp prices decrease and lamp life increases for almost all lamps. If the J-H1 follows this trend it will generally be a more economical lamp to use than the filament lamp for industrial application. Even at its present life and price it compares favorably in high narrow rooms if power costs are high.

TABLE II.—Luminaire Mounting Data—J-H1.

Luminaire	Recommended Minimum Mounting Height	Recommended Maximum Spacing
400-Watt Dome High Bay	18 Feet	1.0 × Mounting Height
Spread	18 Feet	1.1 × Mounting Height
Medium	22 Feet	.9 × Mounting Height
Concentrating	28 Feet	.8 × Mounting Height

Luminaires with spread distribution are recommended where the mounting height is limited or where high levels of illumination are required on vertical surfaces. More light is projected to the wall surfaces so coefficients of utilization are low in high narrow rooms. The medium spread luminaire is very efficient with this lamp and should receive wider use than either spread or concentrating distributions. The concentrating distribution should be used only in high narrow areas.



The E-H1 (left) produces similar, but slightly more concentrating, distributions than the A-H1 lamp. J-H1 (center) distribution curves with high-bay luminaires. A-H12 (right) distribution curve in high-bay luminaire.

The A-H9 (above) is the most economical lamp to use in areas that are wide with respect to mounting height if the power cost is under 1½ cents per kilowatt hour. The A-H12 (right) is the most economical lamp to use in areas that are high and narrow regardless of power cost. Insert shows a high-bay luminaire for the A-H12.

Compared to fluorescent lamps, the J-H1 is more economical only in high narrow rooms. This advantage is possible because a more concentrating distribution can be produced with this lamp than with the fluorescent lamp.

The J-H1 can be substituted for the A-H1 in most installations. In a high-bay luminaire the change increases the beam spread considerably. When the J-H1 is installed in the 400-watt dome the diffusing ring should be removed because the extremely bright arc is no longer visible, although the total candlepower at angles near 45° is increased due to the larger size of the source. Removing the ring also increased the efficiency of the luminaire six to seven per cent. Because of the high lumen output the minimum luminaire mounting height as with all lamps emitting 15,000 to 20,000 lumens, should be about 18 feet, although some installations are satisfactory at lower mounting heights.

The 1000-Watt AH-12

The A-H12, rated at 57,000 lumens and 4000 hours average life, is the most economical mercury lamp available for most general industrial lighting applications. (See Table III.) High efficiency, long life and high light output from a single unit are the most important lamp characteristics that tend to lower lighting cost. The A-H12 has all these features. The size and shape lend the lamp to use in fixtures that provide good shielding from all directions, so from the standpoint of lighting quality it is comparable with or better than many other mercury lamps. Luminaires for the A-H12 can be designed to provide a reasonable degree of control of the light. Thus it is in high narrow rooms that this lamp excels all others, regardless of the power rate or the burning hours per year.

Being a relatively new light source, only a few luminaires have been designed specially for the A-H12. However, it has approximately the same light center length as a 750-, 1000-, or 1500-watt PS-52 incandescent lamp and can be used in some fixtures designed for these sources.

The 3000-Watt A-H9

When the area to be lighted is very large, it is more economical to use a few high-wattage sources than a larger number of lower-wattage sources. For this reason the A-H9 has been widely used and has served economically. Its high lumen output (120,000 lumens) and long life (up to 10,000 hours average) are its greatest assets.

Because of its high brightness and high candlepower this lamp is recommended for use at mounting heights that exceed forty feet. The A-H9 is the most economical lamp to use in areas that are wide with respect to the mounting height if the cost of power is low. Since this is a large source (48" arc length), it is not well adapted to producing narrow beams of light. Its widespread distribution projects a considerable amount of light on the walls in high narrow rooms. This characteristic and its low efficiency (38 lumens per watt including ballast), compared to some other high wattage mercury lamps, limit the economic use of the lamp to large areas where power costs are low.

TABLE III.—Cost Comparisons.[1]
Based on 4500 Hours' Burning Per Year.

Power Cost		$.01 per KWH				$.015 per KWH				$.02 per KWH			
Room Index		J	K	L	M	J	K	L	M	J	K	L	M
At Mounting Heights Over 40 Ft.													
Lamp	Luminaire												
A-H12	Open Al. High Bay	106	100	100	104	100	100	100	100	100	100	100	100
A-H9	3KW Hg. High Bay	120	111	100	100	130	120	107	104	135	125	112	109

[1]The most economical lamp and luminaire is rated as 100 (%). Cost of the other combination is expressed as a percentage of the most economical combination for that room shape and power cost. The cost of labor for cleaning luminaires and for replacing burned out lamps has been omitted.

Cost of Lighting

Lighting economy is dependent upon many factors, factors which make one light source desirable under certain circumstances, undesirable in other cases. Power cost, lamp replacement cost, hours of use per year, and the size and shape of the area to be lighted, vary from one installation to another. In making any cost study, it is imperative that these variables be properly evaluated. Cost studies are valuable when properly made, but misleading when based on improper data. Lighting cost data should include allowances for fixed cost (insurance, taxes, interest and amortization of investment) and operating charges. The operating charges consist of expenses for power, new lamps to replace burnouts, and labor charges for cleaning the luminaires and for replacing the burned out lamps. The labor costs for cleaning and replacing lamps vary considerably but are usually relatively small. These labor charges were not considered in computing the cost data, or in the remarks that accompany the discussion of each lamp.

While Table III should not be used dogmatically to choose the lamp or luminaire for a specific installation, it does present relative cost data that were carefully calculated. Considerable effort was made in the determination of fixed costs to avoid giving any lamp an unfair advantage.

The addition of labor charges for replacing burned out lamps would tend to favor the long-life, high-lumen-output lamps. The inclusion of these labor charges may eliminate the 40-watt fluorescent lamp from consideration in areas where lamps are costly to replace. Large amounts of dust, dirt, fumes, or smoke in an area may make it unwise to use open equipment. The maintenance factors used in the calculations were for medium conditions. In installations where the lighting equipment will collect dirt readily, open type luminaires lose their efficiency much more quickly than enclosed luminaires.

Reflector Floods Used in Warehouse

Reflector floods in one, two and three-lamp clusters supply seven footcandles of the Hanson Storage Co., Milwaukee, Wisc. The lamps mounted at an angle are 300-watt reflector floodlights and those mounted straight are 150-watt reflector floods. Luminaires are spaced at approximately 10 feet and at a ceiling height of 22 feet. Lighting for each bay is individually controlled. Walls are of cement block, the floor is cement and the ceiling is light gray.

Trends in Lighting for Human Comfort

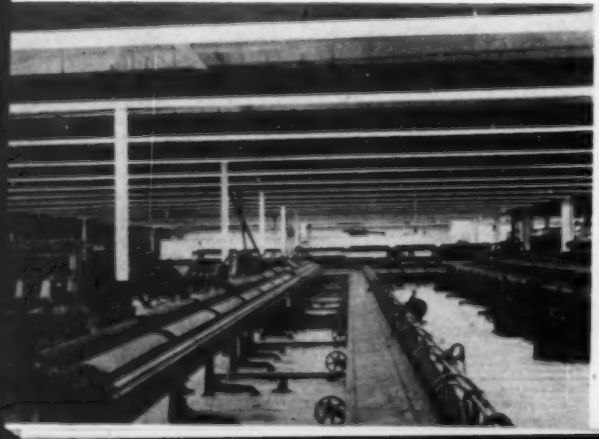
The value of good lighting becomes apparent when complete employee satisfaction is achieved. This is accomplished when brightness ratios throughout shop areas conform to industrial recommended practices. (See page 234.) Illustrated here are some modern applications of advanced lighting installations for production areas.

Figure 1 (left). General illumination with luminaires provides three to five per cent upward light. Localized lighting supplies high illumination levels for critical seeing tasks.

Figure 2 (right). Troffer type luminaires are used for high levels of illumination with maximum shielding. Light floors reflect light to the ceiling to minimize contrast and improve brightness ratios.

Figure 3 (below left). In clean production areas where high precision work is being conducted, brightness engineering is a necessity. Good shielding and brightness control is obtained in this installation where 30-40 per cent of the light is distributed uniformly over the ceiling.

Figure 4 (below right). Well-shielded luminaires with 10-20 per cent upward light can provide excellent seeing conditions when brightness engineering for comfort is satisfied.



What are our aims in providing lighting for industrial workers? Only one important thing: Clarity of vision at the very point of seeing. Lighting must be adequate and without glare (direct or reflected). Shadows must be minimized to reduce contrast and interference with the ease of seeing. Our aim must be

Quality —

Our Next Step in Industrial Lighting

By GEORGE J. TAYLOR

THE ROAD to 50-100 footcandle levels in industrial lighting was traveled, and reached, during World War II, thanks to phenomenal progress in our lighting tools and the recognition of industrialists of its value to production. Seven or eight years of experience under these levels have convinced us all of their part in improved vision and gains in production efficiency.

Now we need quality lighting in our factories. During the last terrible emergency we overcame the limitations of the sources themselves -- 10 per cent light and 90 per cent heat; color quality at a sacrifice of 40-95 per cent of the generated white light; lamps so bright they must be completely shielded or diffused. We overcame the drag in industrial lighting development — and made the words "lighting" and "production" synonymous.

Today we are in a new production era. It has been described as *production for the survival of America*. Charles E. Wilson, Director of Defense Mobilization aptly puts it this way: "The paramount task of American Industry is to lift America's production capacity. This must be no sporadic effort. It must be a long and continuing one, because it is widely recognized that maintaining and improving our margin of superiority in production is our only road to survival. . . ." "Our factories must build up or utilize existing facilities to produce more pieces faster in the most economic way possible. . . ."

Production means not only more per machine, per operator, or per hour, but also the reduction of wasteful spoilage and costly seconds. In spite of high speed automatic machinery, a fast seeing, clear thinking workman is the most important production machine in the factory. Eighty per cent of the workman's actions are eye controlled. Every employer of craftsmen is an employer of *seeing* — he hires not "hands" — but *eyes*.

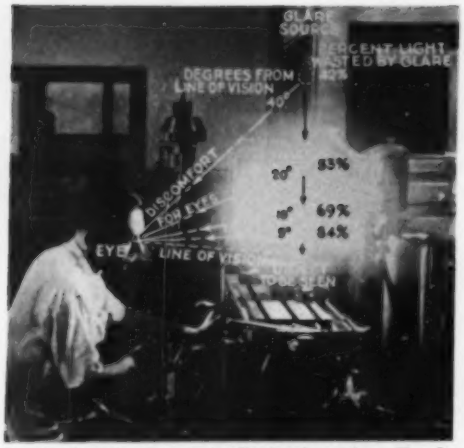
Everything in the plant is fitted to the workman —bench height, handles, stair treads, air supply. The lighting too must be fitted to the workman's visual requirements.

Comfort and Production

Since it is now considered axiomatic that *good light* provides improved sight and results in increased production, it behooves us all to consider for every installation just what good light is. *Good light* is that light which provides ease of seeing and comfort of vision.

Seeing comfort is achieved when two very important factors in lighting are recognized: (1) levels of illumination must be proper for a given visual task and (2) the brightnesses must be well controlled and balanced. Illumination levels for industrial tasks have been prescribed elsewhere in this issue. These recommendations of modern light-

Author: Day-Brite Lighting, Inc., New York, N. Y.



Direct glare is the worst offender in seeing. It robs workers of clear, easy seeing and is the cause of slowing production, building up the stock pile of spoiled material, as well as increasing the toll of industrial accidents. Direct glare can be overcome by proper means of shielding luminaire light sources and preventing light from reaching the eyes at normal viewing angles.

ing practice have so proved their value, they are now taken for granted, understood and applied wisely in proper *quantity* for specific seeing tasks.

No so well understood, however, is brightness engineering, a term which specifically relates to quality. Our next step, that of quality, is slower in coming. But it is the nature of the provision of good lighting in almost all phases of the profession.

Considerable progress has been made since our earliest designs of fluorescent luminaires for office lighting. We are proud of our progress in this direction. Improved luminaire development for office lighting applications has shielded the lamps, controlled the brightnesses, and provided comfort in a high degree.

There is less reason to be proud of the development of fluorescent luminaires for general lighting in industrial areas. Isn't it true that many industrial seeing tasks are just as difficult as those in offices, if not more so? How about typesetting, fine assembly, close machine work, many inspection jobs, examination of cloth, sewing tasks, proofreading, laboratories, to mention a few. In the office the minimum shielding of lamps is given at 25° with 35° preferred and 45° proposed. What about shielding for industrial units? Specified values allow 13° for crosswise viewing with no limit at all set for lengthwise viewing. A more recent specification stipulates 23° crosswise, but still no limit lengthwise. Eggerate type louvers with reasonably good shielding are available but seldom used because quality seems to be a forgotten factor in the language of industrial comfort.

Apparently unconsidered also, is controlled brightness in various zones or angles at which the luminaire is viewed. Only occasionally does one hear about "spilling a little light on the overhead ceiling" in industry. Office louvered luminaires are considered to provide comfort of seeing only when they supply something of the order of 30 per cent upward light with a general preference of 40 per cent or more. Brightness engineering demands a minimum of contrast or brightness ratio for good seeing conditions. Some industrial luminaires are available with an upward component of light between 3 and 4 per cent! Upward light in an amount of 10 to 15 per cent would be more in order for many critical seeing tasks in industry.

There has been some hesitancy by industrial management to use anything but sturdy and strong luminaires. Rightfully so, of course, for factory areas with its machinery and mobile maintenance equipment require the most sturdy lighting units available. Heavy duty channels with detachable porcelain enamelled reflectors are almost universally used. No argument here either, except that improved upward light is in order, at least in an amount of not less than 10 per cent to fight overhead contrast.

There is a notable absence of lighting comfort in many industrial areas resulting in a sacrifice in production output and in the quality of merchandise produced. Yet the quality of light equals quality of product. These areas can and should be comfortably lighted. In some instances, where seeing tasks are truly critical these areas warrant lighting of even greater comfort quality than office areas. It is worthy of much thought and serious consideration by all in the lighting profession and by manufacturing concerns using lighting.

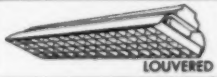
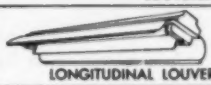
Comfort Offenders

The elements contributing to visual discomfort have been expounded elsewhere, and often. So prevalent are they in many industrial areas, however — perhaps adequately lighted in other respects — they may bear repeating.

Direct glare is probably the worst offender, whether from natural or artificial lighting. The more of it in the worker's eye, the less he sees. When a direct glare source is within 5 degrees of the line of vision, as much as 80 per cent of the illumination falling on the work may be wasted, and even if the angle is 40 degrees of the line of

CLASSIFICATION OF STANDARD TYPE INDUSTRIAL LUMINAIRES

Equipped with Porcelain Enamel Reflectors
Using Fluorescent Lamps

TYPE OF LUMINAIRE		TWO 40-WATT LAMPS*			THREE 40-WATT LAMPS*			TWO 85-WATT LAMPS		
		All Light Down	3-5% Light Up	10-15% Light Up	All Light Down	3-5% Light Up	10-15% Light Up	All Light Down	3-5% Light Up	10-15% Light Up
LOUVERED	CLOSED END UNITS	I	IA	IB	IC	ID	IE	IF	IG	IH
LONGITUDINAL LOUVER		II	IIA	IIB	—	—	—	—	—	—
OPEN		III	IIIA	IIIB	IIIC	IIID	IIIE	IIIF	IIIG	IIIH
 LOUVERED	OPEN END UNITS	IV	IVA	IVB	IVC	IVD	IVE	IVF	IVG	IVH
 LONGITUDINAL LOUVER		V	VA	VB	VC	VD	VE	VF	VG	VH
OPEN		VI	VIA	VIB	VIC	VID	VIE	VIF	VIG	VIH

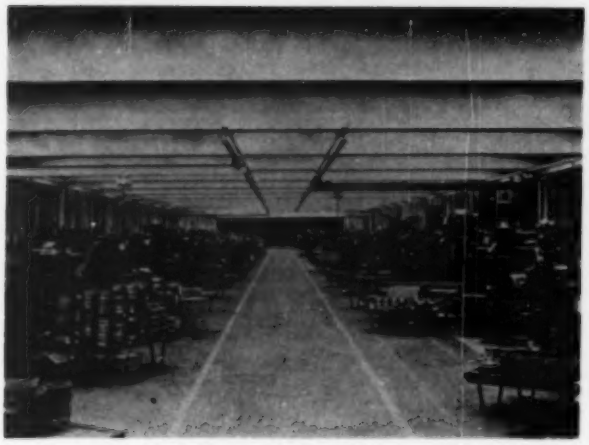
*Also available for T-12, 96", 75-Watt Slimline Lamps.

SELECTION OF PROPER INDUSTRIAL LUMINAIRES

With Relation to Severity of Seeing Tasks

RECOMMENDED PRACTICE INDUSTRIAL LIGHTING	FOOT-CANDLES	PREFERRED	SATISFACTORY	ACCEPTABLE
MOST DIFFICULT SEEING TASKS Finest precision work involving finest details—Poor contrast—Long periods of time.	200-1000	Supplementary Luminaires—Mounted ABOVE eye level I - IC - IF	IV - IVC - IVF	II - V
		Supplementary Luminaires—Mounted BELOW eye level III - IIIC - IIIF	VI - VIC - VIF	
VERY DIFFICULT SEEING TASKS Precision work involving fine detail—Fair contrast—Long periods of time.	100	IB - IE - IH IVB - IVE - IVH	IA - ID - IG IVA - IVD - IVG	IIB - VB
DIFFICULT AND CRITICAL SEEING TASKS Prolonged work involving fine detail — Moderate contrast—Long periods of time.	50	IB - IE - IH IVB - IVE - IVH	IA - ID - IG IVA - IVD - IVG IIB - VB	(I - IC - IF IV - IVC - IVF)† IIA - VA
ORDINARY SEEING TASKS Involving moderately fine detail—Normal contrast—Intermediate periods of time.	30	IIB - VB	IIA - VA	(II - V)† IIIB - IIIE - IIIH VIB - VIE - VIH
CASUAL SEEING TASKS	10	IIIA - VIA	III	VI
ROUGH SEEING TASKS	5	III	VI	Incandescent Lamps

†Ceilings, overhead pipes, etc., should be painted white. Seeing tasks and general surroundings should have high reflectances to reflect ample light to ceiling.



Were it not for the deep natural beams painted aluminum, this part of the shop might have taken on an atmosphere of a dungeon, typical of many work areas with dark ceilings. Standard industrial luminaires directing light downward are used, but are completely shielded by the beams. The beams are uniformly illuminated to blend into a single ceiling pattern.

vision, 42 per cent of the light on the work may be wasted.

Reflected glare is a close competitor for the dishonor of being the worst offender against good lighting practice. It is negative light like direct glare only more insidious, especially when it is reflected from the detail to be seen. While in many cases it may be less of a hindrance to seeing because of the usually lower brightness, the fact remains that it quite often falls directly in the line of vision and, therefore, cannot be always avoided by shielding, particularly since it may come from below the line of vision rather than from above it.

Shadow is another adverse factor in the ease of seeing, figuring heavily in the annual toll of industrial accidents. On the one hand, shadows reduce the illumination on the work within them, and on the other produce undesirable brightness contrast.

Continuous rows of fluorescent luminaires mounted on close centers provide high levels of illumination for quick and easy seeing. Light floors redirect much of the illumination back to the ceiling, adding to eye comfort.

Quality Illumination

Ideally, for the most comfortable seeing conditions, surroundings should be of the same order of brightness as the work. This is rarely feasible in the work-world, however. In fact it may even be desirable to have the work somewhat brighter than the surround to claim the involuntary attention of the worker.

From the normal point of viewing, however, ratios of brightness of areas of appreciable size should not exceed those established by the proposed Standard of Industrial Lighting, given on page 234 of this issue. These ratios are recommended as minimums; reductions are generally beneficial.

A lighting system in itself cannot always produce quality illumination even though it may be the best that can be provided for the job under consideration. Other important factors are necessary to complete accuracy and comfort of vision—factors we can all watch for in industrial installations.

Ceilings painted with a high reflectance white matte paint can be recommended, for instance. Walls should provide some tinted color to enhance the aesthetic sense of all classes of workers. The

color best suited for the job may vary with the light source used, fluorescent, mercury or incandescent, and with the effect desired in terms of the use of cool or warm colors. Of first importance, however, is the use of colors having relatively high reflection factors. Obviously walls of 60 per cent reflectance are out of order in a foundry but highly desirable in an inspection area where small parts are being examined.

By the same reasoning, floors should be as light in color as practicable. So should bench tops and machinery.

The Answer for Comfort

In 1941 we met the demand for more production with more light as a logical step for improved seeing. In 1951, we take the next logical step and raise the comfort of seeing through improved quality. Accomplishing this latter step is a comparatively simple matter, requiring but a few minor considerations, which nevertheless are of major importance:

Ceilings. — Avoid dark ceilings — paint white. Use luminaires with suitable upward light component.

Walls. — Avoid dark walls — a wide choice of hues and tints may be used. Green colors are conducive to coolness while buffs give a feeling of warmth.

Immediate Surround. — Surfaces adjacent to the task being viewed should avoid harsh contrasts — includes machinery and bench tops.

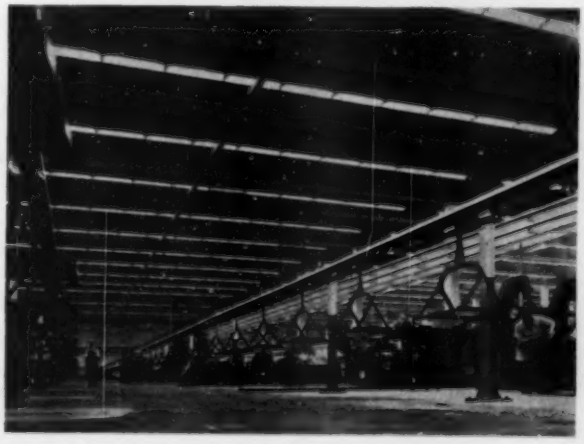
Floors. — Avoid Dark Floors. Contrary to opinions light floors in many industrial areas show dirt less than dark floors.

Glare. — Eliminate to as great an extent as possible. Use well shielded luminaires. Minimize reflected glare with proper positioning of luminaires. Diffuse luminaires very often desirable.

Shadows. — Avoid harsh shadows which produce bad contrasts; directional lighting by proper positioning of light sources important. General distribution of light should be uniform.

The "grid" system of luminaire spacing is gaining in popularity. High levels of illumination are attainable with desirable cross reflection of evenly distributed light resulting in a notable reduction of shadows at working points. Three-dimensional seeing by proper application of paint on machinery reduces brightness ratios throughout the room.

With these few simple rules quality of lighting may be obtained. The return on whatever small amount of additional investment may be involved will be overwhelming. Aside from any increases in production, reduced errors and spoilages and fewer accidents, watch employee reaction in pride of better housekeeping, general morale and less irritation.



The use of fluorescent lighting is not limited to mounting heights of 10 or 12 feet. Excellent results are obtained at heights of 20 to 30 to 40 feet in large factory areas with savings in costs and improved comfort of vision comparable to that of lower mounting heights.

Pointers for Proper Maintenance

Whether fluorescent, incandescent or mercury, like production equipment and tools, an industrial lighting system requires maintenance at regular intervals. Follow these seven steps to help keep lighting systems at maximum efficiency.

- **Make periodic lightmeter check-ups ——**

All lighting installations show a loss in light output from their initial light level due to lamp burn-outs; dirt collection; and other causes such as lamp depreciation, voltage drops, and light absorption by dirty walls and floors.

Lamp outages are readily seen but the other factors cause the slow but steady depreciation not easily detected by the human eye which is a poor measuring instrument. Therefore, it is desirable that periodic check-ups be made with a lightmeter to determine whether cleaning, painting, and voltage inspections are necessary.

- **Clean or repaint walls and ceiling regularly ——**

The color of the walls, ceiling and floor in a plant greatly affects the light output of the lighting installation. Dirty or dark walls and ceilings may absorb as much as 80 per cent of the light which strikes them. Light colored surfaces, on the other hand, reflect light. Therefore, if walls, floor and ceiling are dark in color, it will pay to consider repainting. Those plants with light colored ceilings, wall and floors should establish a schedule of cleaning and repainting.

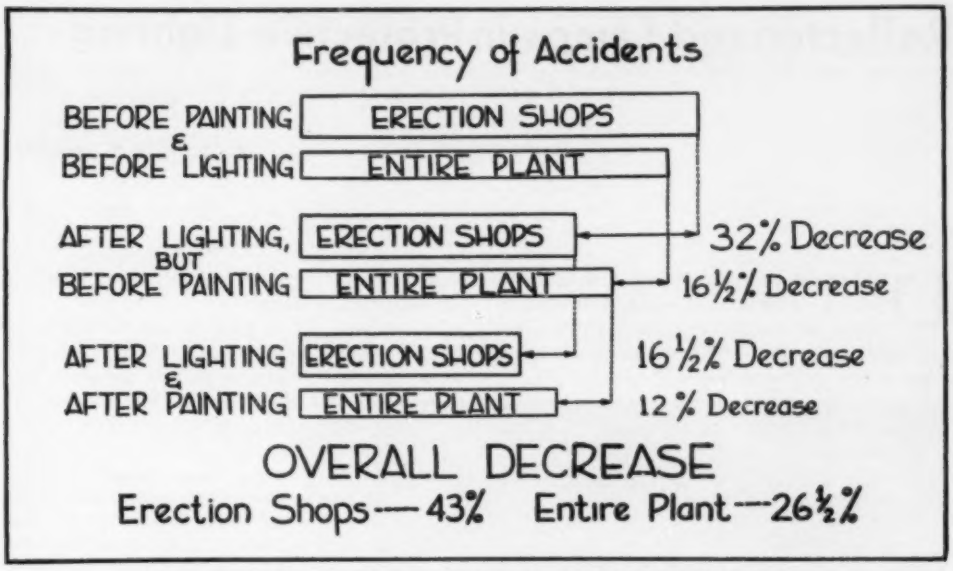
- **Establish a regular cleaning schedule ——**

Dirt and dust are the greatest enemies of the lighting system. They may cut light output by 50 per cent in a comparatively short time. It becomes important, therefore, that a regular cleaning schedule be established for lighting systems. The appropriate and economical time between cleanings varies with the rate of dirt accumulation. In some locations cleaning every two weeks is necessary. In others, twice a year may be sufficient. Factors in a plant, and lightmeter readings will dictate the schedule to be followed. When cleaning, both fixtures and lamps should be thoroughly washed, not just wiped with a damp cloth. Supplier of cleaning materials can recommend a good cleaner for lamps and fixtures.

- **Check regularly for burned-out lamps ——**

Too often lighting systems are installed to provide high levels of illumination necessary for precision work. Then, due to faulty maintenance, burned-out lamps are not replaced and the high level of illumination falls off markedly. This is poor economy and usually shows itself in increased production spoilage, lowered production and increased accidents. Regular checks should be made for burned-out lamps and replacements made.

There are two general methods of replacing lamps — individual replacement and group replacement. For factories where groups of lamps are burned continuously for any prescribed time it will be found that the cost of light will, in general, be cheaper if a group replacement schedule is followed. With this method all lamps in an installation are replaced at one time, eliminating the necessity of bringing in ladders and replacing individual lamps daily as they burn out. Ordinarily when about 10 per cent of the lamps burn out the remaining lamps will begin to burn out rapidly and those lamps which still burn begin to depreciate or produce less light. At this point, all lamps should be replaced; this also provides an economical time to wash the lighting fixtures which in reality brings the lighting value back to its initial efficiency.



Frequency of accidents in a large manufacturing plant is reduced by light and paint.

- **Maintain proper voltage** ——

All lamps, incandescent, fluorescent and mercury, are designed to give rated lumens output at a determined voltage. When the line voltage increases or decreases within certain limits, light output or lamp life suffers. To get the most economical operation from incandescent lamps, it is necessary to specify lamps designed for the line voltage in the plant. With fluorescent and mercury lamps the voltage designation is not necessary since this is controlled by the ballasts. These ballasts have voltage ranges and when an installation of either fluorescent or mercury lamps is contemplated the ballast rating closest to the voltage measured must be specified.

Overloading lighting circuits in a plant should always be avoided. Regular voltage checks should be made to see that it stays within close limits. If checks show that line voltage varies considerably, it will be advisable to install voltage regulating devices.

- **Keep a stock of equipment parts** ——

Production may be halted or impaired by a break-down of the lighting system in any part of a plant. Therefore, it is important that a plant have on hand a complete stock of lighting parts — reflectors, lamps, sockets, ballasts, etc. The quantity of stock items required to keep a lighting system in good operating condition will naturally depend upon the number of luminaires in service. Check sheets are available for this purpose.

- **Labor-saving maintenance devices** ——

There are now available many devices that may simplify the maintenance problem. It pays to consider the use of those suited to specific operations and type of building construction. When possible, disconnecting reflectors should be utilized and cleaning and relamping accomplished on the floor rather than at the outlet.

From a speech by G. J. Taylor before the Cleveland Section of I.E.S., January 10, 1951.

Reflectorized Lamps in Protective Lighting

By ROBERT T. DORSEY

DURING World War II reflectorized lamps proved to be a convenient and effective means of lighting. Subsequently, their use has rapidly expanded in fields such as gas stations, signs, sports, and work areas.

Reflectorized lamps applicable to protective lighting are shown in Table I.

Fundamentally, reflectorized lamps have two unique attributes:

1. The reflector cannot be corroded by atmospheric conditions.
2. Initial efficiency of the lighting system is automatically restored each time a lamp is replaced. Radical savings in labor cost for cleaning can result.

The application of these lamps is similar to enclosed floodlights of comparable wattage and beam characteristics and the same methods of calculation can be used. Some saving of critical material can be effected with the simpler types of holders for reflectorized lamps.

Author: General Electric Co., Nela Park, Cleveland, Ohio.

In comparison with high-wattage floodlights, it becomes apparent that large numbers of reflectorized lamps are needed to provide the same illumination over a given area. While wattage required is comparable, lamp cost is higher.

From the standpoint of security it is obvious that the failure of one or two reflectorized lamps of a group is not as serious as one or two failures in a small number of larger lamps. Moreover, a relatively large number of lamps spaced along a building parapet or in small clusters on poles or structures can be individually placed and aimed to practically eliminate shadows in spaces such as lumber yards, storage areas, tanks, railroad sidings, etc.

Recent developments in very narrow beam projector lamps extend the range of applications.

PAR-38 floodlamps on 19-foot centers provide security throughout the roadway and parking area. Because of the projecting cornice, the building face itself is dark, but there is no shadow area to conceal a person walking along beside the building.

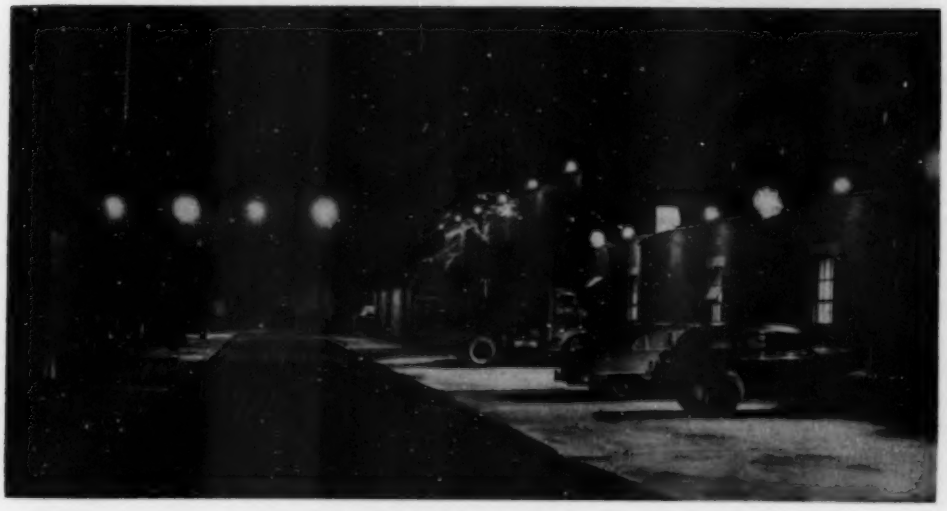
TABLE I.—Reflectorized Lamps for Protective Lighting.

Description	Watts	Bulb	Approx. Beam Spread	Approx. Initial Beam Lumens	Approx. Initial Max. Candlepower
REFLECTOR					
Indoor	150	R40*	30°	600	7000
(Satisfactory outdoors if	150	R40*	60°	800	1400
protected from rain)	300	R40*	30°	1350	16000
	300	R40*	60°	1600	2800
Outdoor	300	R40	30°	1350	16000
	300	R40	60°	1600	2800
PROJECTOR	150	PAR 38	30°	1150	12000
(Outdoor)	150	PAR 38	60°	1400	3500
	200	PAR 46**	16 x 23°		50,000
	300	PAR 56**	12 x 19°		100,000

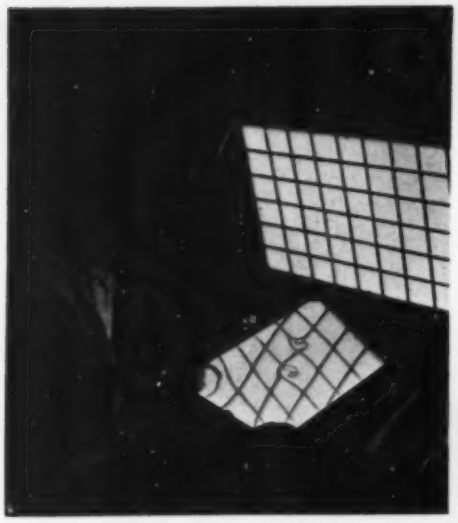
*Bulb is of ordinary blown glass and should be protected from thermal shock caused by contact with liquids or metal.
**Upper portion of lamp should be shielded from rain.

Lighting of irregular areas (right) is facilitated by groups of individually aimed projector lamps. Simple mounting is accomplished with conduit fittings. Here only one of several clusters is turned on. Three PAR-38 spotlights cover the corner and the foreground, and the two PAR-56 narrow-beam lamps cover the longer throws toward the next building.

Note how shadow areas (below) that could conceal an intruder are practically eliminated by the multiplicity of distributed PAR-38 floodlamps. Outage of a few scattered lamps would still leave the system relatively effective.



Some Inspection



Specular material can be inspected by viewing a reflection of a pattern in the material. Irregularities in the reflection indicate the surface defects in the material. Either the observer, the material or the pattern must move to be sure that the whole surface is covered.

The unit contains three 15-watt fluorescent lamps behind a frosted plastic panel on which the grid pattern is painted.

The seams of the parachute are inspected by transilluminating the material. The unit consists of several fluorescent lamps mounted below the diffusing glass panel in the table top beneath the parachute. The operator sees a large area of the parachute transilluminated uniformly and comfortably, and easily picks out such defects as broken threads.

Similar installations using large-area, low-brightness units can be used effectively in the inspection of other transparent or translucent objects.

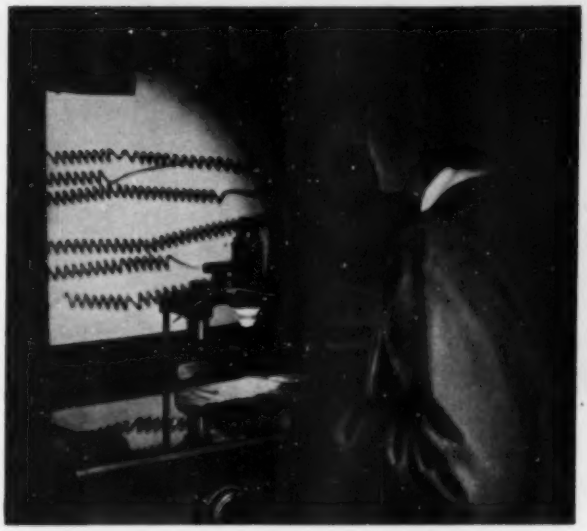
Each unit contains three 40-watt fluorescent lamps. The equipment is recessed to keep it out of the way and to minimize breakage from falling objects. The glass covers on the units protect the lamps in addition to making cleaning easier. Mounting is on about 7-foot centers and there are approximately 40 footcandles on the bottom of the vehicle.

Pit areas may be classed as hazardous, in which case solid glazing with access from the rear may be required.

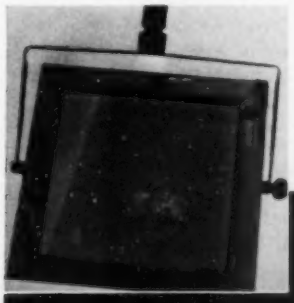
Techniques

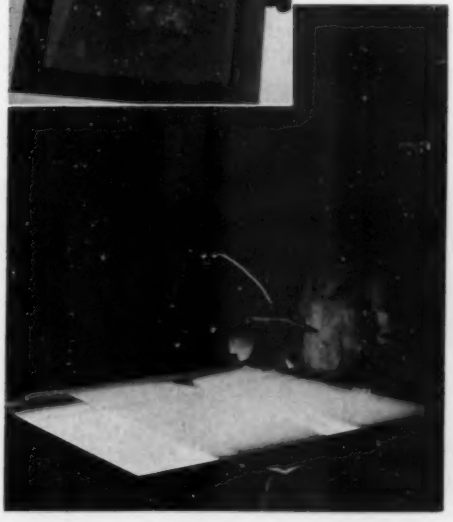
Here lamp filaments are inspected by projecting their image on a screen. The details can be magnified up to 100 times making defects more easily visible. This technique may be applied to many such jobs.

In this device, a filament lamp is used in a condenser-type illuminator under the table. The filament is placed under the microscope and the image is reflected from a mirror on to the screen in front of the operator.



Vinyl laminate for safety glass is inspected with the aid of polarized light (below left). Forty-watt fluorescent lamps are mounted behind the diffusing glass on 3-inch spacings, and a polarizing screen is put over the glass. The vinyl is placed on the top of the unit and viewed through another polarizing screen. The inspector sees defects in the vinyl as brightness differences on an otherwise dark background as shown in close up.





Transparent material can be inspected for interior and surface defects by edge lighting (below right). When the material is viewed against a dark background, defects appear as bright spots in the material. The light comes from a 15-watt fluorescent lamp mounted behind a slot in the box.

High Bay Installations of Mercury Lamps

HIGH BAY areas in the Cleveland press shop shown above consist of three adjacent craneways, each 100 feet wide. Two of these bays have a truss height of 44 feet and a third a truss height of 39 feet. Three rows of 3000-watt mercury luminaires have been installed in each bay on a spacing of 20′ by 30′4″. To serve as auxiliary lighting in the event of a power interruption on the mercury lighting, each bay also has two rows of 1500-watt filament high bay reflector lamps.

Average illumination measured after one year of service was 70 footcandles, with no drop-off between the bays and under the crane girders. There are no shadows in these areas, even between the high presses, and excellent visibility is noticed in the presses without supplementary lighting.

The three-kilowatt luminaires are of porcelain enameled steel reflectors with open ends and a ventilated wireway channel, having a 30-degree shielding angle below horizontal.

In this installation, the 3-kw mercury lighting is supplied from three-phase 460-volt three-wire bus ducts mounted along the column at the trust cord level. Three-phase contactors are mounted on the bus duct and controlled by 115-volt pilot circuit by single-pole toggle switches. These are six 3-kw units per circuit with two units on each phase.

A large-area installation of 1000-watt mercury lamps in a Michigan press shop is shown at right. In this area, 80 feet wide, four rows of luminaires are mounted 30 feet high on 20- by 24-foot spacing. Initial illumination level was 70 footcandles, and it is expected that a maintained level of 50 footcandles will be obtained. Each luminaire consists of an aluminum high way reflector treated by the Alzak process for permanence, and finished with a black enamel on the outside for dissipation of heat.

Each reflector is equipped with a 1000-watt AH-12 mercury lamp. Each luminaire is operated from a single-lamp high power factor ballast which is installed on the roof truss adjacent to each reflector, as shown in the photograph. The complete lighting system is operated from a 460-volt three-phased three-wire supply. Ballasts are designed for this primary voltage, but the secondary open circuit voltage of the ballasts is only 220 volts, to minimize the electrical hazard to maintenance personnel who replace the lamps while the system is in operation. Shielding angle of the reflector of the luminaire is 32° below the horizontal from the edge of the reflector to the bottom of the arc of the lamp.

Normal operation in this shop will be with straight mercury lighting. However, the old lighting with filament lamps will remain in service as a stand-by in the event of power interruption.

Data and photographs supplied by W. H. Kahler, Westinghouse Electric Corp., Cleveland, Ohio.

Explosion-Proof Lighting

By ERIC H. CHURCH

HAZARDOUS locations may be defined as locations where gases, vapors, and dusts are or may be present in the atmosphere in sufficient quantities to produce explosive or ignitable mixtures.

Hazardous locations are not limited to gunpowder plants, gasoline refineries, or grain elevators. Practically all manufacturing plants contain hazardous areas. These locations may be grinding mills, paint spray booths, sorting rooms, etc. It is important, therefore, to recognize hazardous locations and to make adequate provisions for safe lighting equipment. Statistics of one insurance company show that 63 per cent of all electrical fires occurred in areas that could have been classed as hazardous locations.

It is an understatement to say that hazardous locations are usually inadequately lighted. The poor lighting in these areas can generally be attributed to three facts:

1. The owner or plant engineer is unaware that certain locations in the plant are hazardous and is also unaware that there are proper lighting units available for such locations.
2. The local inspection authorities are not versed in hazardous location work and are unaware of the proper equipment to use.
3. The belief that the cost of installing such equipment is excessive.

The first two factors can be corrected by education, publicity, and tightening up of regulations by local authorities. The third factor can be overcome by the realization that the installation of proper equipment is economical insurance. For example, a million-dollar airplane hangar fire in a large Southwestern city could probably have been prevented by the expenditure of a few hundred dollars for explosion-proof lighting equipment.

National Electrical Code

Because of the difference in characteristics of hazardous atmospheres, the design and construction of equipment for use in a specific hazardous location must take into account the characteristics of that atmosphere. Article 500 of the National Electrical Code defines hazardous locations and establishes three classifications in order that the inspection authorities enforcing the Code may determine the need for explosion-proof or dust-tight equipment in any area.

These classifications and definitions are:

Class I Locations: Those in which flammable gases or vapors may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. The locations are subdivided into:

Group A. Areas containing acetylene.
Group B. Areas containing hydrogen or manufactured gas.
Group C. Areas containing ether vapors.
Group D. Areas containing gasoline, alcohol, etc.

Class II Locations: Those which are hazardous because of the presence of combustible dust. The locations are subdivided into:

Group E. Areas containing metal dust.
Group F. Areas containing coal dust, carbon black.
Group G. Areas containing grain dust.

Class III Locations: Those in which easily ignitable combustible fibres such as cotton, hemp, kapok, etc. are stored and handled.

Lighting Units for Class I Locations

It can be expected that some gas will be present in a lighting unit installed in a gaseous atmosphere. A spark occurring inside the unit can be expected to ignite or explode the gas present and, unless proper lighting equipment is used, disaster can result.

The mechanical design of lighting equipment for use in these locations must solve the problems of providing sufficient strength to contain the explosion, sufficient cooling to prevent the exterior surface temperature of the equipment from igniting the gas in the external atmospheres and a proper escape route for the internal gases so that they will be cooled and all flames extinguished before reaching the outside.

As an example, consider Class I, Group D lighting equipment for use in atmospheres containing gasoline vapors. A standard gasoline-air mixture has an ignition temperature of 527°F and will generate explosion pressures inside the equipment running from 75 to 200 pounds per square inch. A Class I, Group D unit, including the enclosing

Condensed from material on Lighting for Hazardous Areas, prepared for the Chicago Electrical News. Author: Benjamin Electric Manufacturing Company, Des Plaines, Illinois.

Figure 1 (left) shows a typical incandescent lighting unit for Class I, Groups C and D locations. Figure 2 (right) shows typical fluorescent unit for Class II, Groups F and G and Class III hazardous locations.

globe, must consequently be fabricated of such materials and thicknesses as to withstand pressures of 200 pounds per square inch. Temperature limitations are met by restricting the size of lamp used and by providing sufficient radiating area to keep surface temperatures below 527°F. The snuffing out of the flame or cooling of the escaping gas after an explosion has taken place in the unit is accomplished by assuring close, accurately machined metal-to-metal surfaces. It has been established that a minimum of five thread engagements is necessary and that all joints must have surface areas of not less than ¾-inch metal contact width with a clearance of .0015 inch.

Figure 1 illustrates a typical incandescent lighting unit such as listed by Underwriters' Laboratories for Class I, Groups C and D hazardous locations.

Lighting Units for Class II Locations

Class II locations are those which are hazardous because of the presence of combustible dust. The considerations in the design of Class II equipment are entirely different from those of Class I. In Class I equipment it is expected that gas might enter a lighting unit and possibly explode, and the design considerations are to keep the heat and flame within the fixture. In Class II equipment it is recognized that the dust particles are much larger than gas, and, therefore, can be kept outside of the lighting equipment. The basic design considerations are to keep the dust out of the device and have the external temperatures low enough so that the dust cannot be ignited.

Lighting equipment of this class must be gasketed carefully so that the normal breathing cycle of on-off operation will not draw the dust inside. Although the method of sealing is not prescribed, asbestos gasketing is widely accepted since it does not deteriorate through exposure to light or usage.

Figure 2 illustrates a typical fluorescent lighting unit such as listed by Underwriters' Laboratories for Class II, Groups F and G and Class III hazardous locations.

Code Requirements for Wiring

Any discussion of lighting for hazardous locations would not be complete without a few words on wiring. Briefly the wiring requirements as specified in Article 500 of the National Electrical Code are:

1. For all classes, rigid metal conduit must be used.
2. Conduit must be screwed into hubs of approved fittings, boxes, switches, suspension covers, etc. There must be an engagement of at least five threads.
3. For Class I wiring conduit runs must be sealed off within 18 inches of any device that can cause arcing or sparking. Sealing compound must be such as to be insoluble in gasoline or vapors that may be used in the atmosphere where the installation is used. Sealing compounds shall not have a melting point of less than 93°C (200°F). Sealing thickness must be the diameter of the conduit, or in no case less than ⅝ inch.
4. Each run of conduit from a hazardous location to a non-hazardous location should also be sealed, preferably just outside the hazardous area.

Hazardous Locations

The general areas in which hazards are likely to occur, calling for a lighting installation conforming to the requirements indicated above include:

Class I. Dry cleaning and dyeing plants, plastic manufacturing plants, paint spray booths, gas plants, paint and varnish manufacturing plants, distilleries, manufacturers of industrial alcohol and meter houses, pumping stations, etc., in gas industries.

Class II. Starch manufacturing, sugar refining, grain elevators, wood-working plants, sulphur crushing and pulverizing, hard rubber recovery, cork pulverizing, aluminum, zinc and magnesium plants, fertilizer plants, powdered milk plants, chocolate and cocoa manufacturers, many plastic manufacturers and textile mills.

Lighting a Steam Turbine Room

LIGHTING OBJECTIVE: To illuminate a large high-ceiling industrial area uniformily in accordance with current lighting practice.

Figure 1.

Installation at Harbor Steam Plant Generating Station, Wilmington, California (Department of Water and Power, City of Los Angeles).

General Information: The area shown in the photograph houses five main turbines and two auxiliary turbines. Room dimensions are 475 x 100 x 49 feet. Surface characteristics are as follows:

turbines	grey	75% RF
ceiling and walls above trusses	ivory	75% RF
floor	red	30% RF

Installation: Mercury vapor and filament lamp luminaires are installed in pairs as indicated in Figs. 2 and 3. Emergency lighting consists of pairs of Smoot-Holman No. 121610 deep bowl luminaires

(over)

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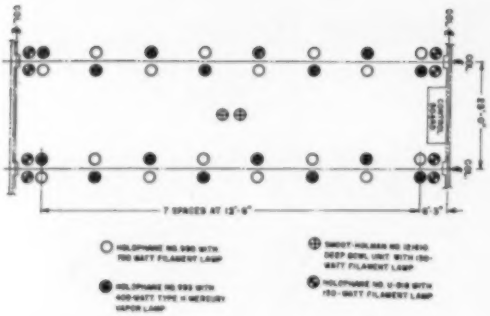

Figure 2. (above) *Plan view of typical bay.*

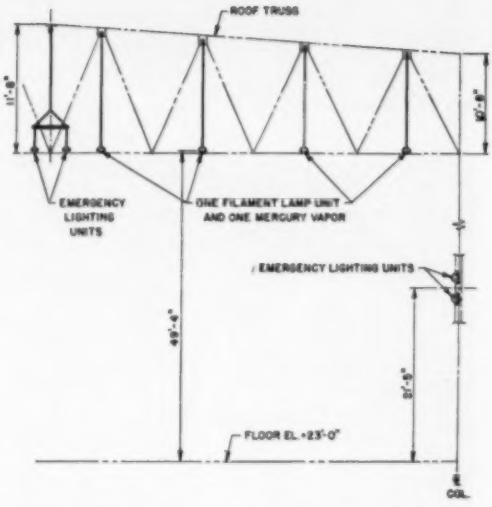

Figure 3. (right) *Cross section of typical bay.*

mounted 25 feet apart down the centerline of the room operated in series from a 250-volt a-c line or battery. In addition, two Holophane U-818 units containing 150-watt filament lamps (in series on 250-volt a-c or d-c supply) are mounted on each wall column along the length of the room and alternate columns along the width.

Average room illumination is 28 footcandles between rows of luminaires and 34 footcandles directly beneath them with a total power consumption of 3.31 watts per square foot.

Lighting data submitted by Illuminating Engineering Unit, Department of Water & Power, City of Los Angeles, as an illustration of good lighting practice and to aid in the design of similar installations.

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TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Summary of Action Taken at April Council Meeting

The I.E.S. Council convened April 5 at the Edgewater Beach Hotel, Chicago, Illinois, with 34 members of Council and local visitors in attendance. Officers of the Chicago Section were invited to afford themselves this opportunity to observe the national group in action, both the Chairman, C. B. Pederson and the Secretary, W. A. Weibel, attending, the latter as a proxy. Another visitor of note was Mr. Robert S. Burton, Sr., a Member Emeritus of the Society for the past 12 years whose interest in Society affairs continues active past his retirement from active business. Those present included: President Walter Sturrock, presiding; C. H. Goddard and Lee E. Tayler, Past-Presidents; S. G. Hibben and E. M. Strong, Vice-Presidents; G. K. Hardacre proxy for A. H. Manwaring, General Secretary; R. F. Hartenstein, Treasurer; W. C. Brown proxy for Roy A. Palmer, Myrtle Fahsbender, R. L. James proxy for R. L. Biesele, Jr., P. F. Kauffman proxy for L. A. Hobbs, H. P. Steele, W. A. Weibel proxy for Duncan M. Jones, Directors; Job B. Browder, J. R. Chambers proxy for C. O. Martin, George F. Dean, Charles N. Laupp, Joseph S. Schuchert, R. G. Slauer, F. C. Winkler, Regional Vice-Presidents; A. D. Hinckley, Executive Secretary; C. L. Crouch, Technical Director; Ruby Redford, Editor; C. E. Ellis, Advertising and Promotion Manager; and Robert S. Burton, Sr., H. E. Carney, George Clark, E. C. Huerkamp, J. O. Krachenbuehl, R. R. Lusk, C. B. Pederson, C. C. Shotwell, M. W. Waterman and C. W. Zersen.

A moment of silent tribute was observed by Council for the late Past-President R. W. Staud, following which a resolution of appreciation was adopted unanimously, to be entered in the Minutes, copies to be sent to Mrs. Staud and the Benjamin Electric Mfg. Co. Details of the resolution are shown elsewhere on this page.

Membership Elections

The Board of Examiners offered for approval the election, transfer and reinstatements of 17 Members, and reported the election of 76 Associate Members and 14 Students. Favorable action on the report brings the present membership to that shown in the following tabulation:

September 30, 1950		April 5, 1951
7057	Total Membership	7303
32	Members Emeritus	34*
41	Fellows	42
1610	Members	1681
5005	Associate Members	5242
369	Student Members	304

*Includes 11 Fellows of the Society.

New Task Committee For Civilian Defense

Following the confirmation of a number of appointments to existing committees, President Sturrock presented for approval the establishment of Task Committee on Lighting for Civilian Defense, of the Defense Coordinating Committee. The proposed scope of this new Committee is as follows:

"To appraise and report on special lighting problems connected with emergency military operations that directly involve civilian defense and protection, such as equipment for bomb shelters, special street and vehicular lighting; and the continuation of services or control of panic conditions."

Following discussion, action was taken to approve the establishment of this committee and to confirm the appointment of committee personnel, for which a chairman will be named. Those named for service on the new committee were: R. B. Brown, Jr., Harry Grattan, Jr., K. E. Hollingsworth, W. F. Little, Kirk M. Reid, T. H. Shepherd, L. J. Shrenk and J. S. Walsh.

Be It Resolved

upon the recent passing of our Past-President Rudolf W. Staud that the officers and Council of the Illuminating Engineering Society hereby express their appreciation and gratitude for the many great contributions which Mr. Staud, during his lifetime, made to the advancement of the entire field of lighting and to this Society in particular.

Under his inspired leadership and guidance numerous important programs were initiated and carried to fruition for the benefit of the entire lighting industry. No one in our field gave more unselfishly of his time and talents in the development of standards and specifications and other practices of great value.

In his service to the Illuminating Engineering Society Mr. Staud displayed those statesmanlike qualities and unusual devotion which prove an inspiration to the younger men of the industry.

Not only will the constructive work which he accomplished continue to be an influence, but Rudy Staud, the man, will always be recalled with great affection by the Illuminating Engineering Society.

Sustaining Membership

C. C. Shotwell, Chairman of the Sustaining Membership Committee, outlined for Council's information a special project undertaken by his committee in which industry classifications are being studied to develop prospective memberships on a comparative basis with relation to the position they occupy in the industry.

Local Activities

President Sturrock reported on his visits to the Southwestern Region, South Pacific Coast Region, and Pacific Northwest Region, recently completed. Mr. Sturrock referred to the excellent Charter meeting held by the Mexico Chapter, which he attended in Mexico City, mentioning the beautiful gavel which had been received by the new Chapter from the next youngest Northwestern Ohio Chapter. He also referred to the hardship felt locally in Mexico, as a result of the large difference in monetary exchange.

Publications

E. C. Huerkamp, Chairman, reported on the status of various projects now underway by his committee. The Handbook Revision project was reported progressing favorably, to be available October 1951 as scheduled. He noted that the new book is an almost total revision, and is some 100 pages longer than the first edition.

The Membership Roster project was reported close to completion with copies to be available during May, at $2.00 per copy.

Future Technical Conferences

R. F. Hartenstein reported on the final arangements being made for the conferences scheduled August 27-30 of this year in Washington, D. C., on September 8-13, 1952 in Chicago, Illinois, and September 14-18, 1953 in New York City.

Mr. Hartenstein referred to several Section's invitations his committee had received for the 1954 Conference, which are now being considered by the National Technical Conference Committee.

In regard to the coming Conference in Washington, George Clark, of the Capital Section, outlined plans his local conference committee have for arranging special train schedules from Chicago which would take in sight-seeing trips at Monticello, continuing to Washington by bus.

Hoyt Steele, Chairman of the Papers Committee, indicated that 42 technical papers will be presented at Washington.

Professional Requisites

Prof. John O. Kraehenbuehl, Chairman of the Requisites Committee outlined five points currently under study by his committee. Priority studies of the committee included membership grades, privileges of the various grades of membership, dues, and relationship of I.E.S. to professional engineering societies.

Technical Program

C. L. Crouch, Technical Director, reported to Council on the progress of the Society's technical program, and on several interesting projects in particular. He noted that the Office Lighting Committee has initiated some basic studies on direct and reflected glare, and are proposing to make extensive studies and calculations as to glare evaluation on office lighting tasks.

The Supplementary Lighting Committee is now preparing its report on an extensive study they had undertaken on how tasks are seen.

He reported that the Lighting Maintenance Committee had met in Washington recently, and are pursuing their course of making lighting maintenance tests. Once they have established a standard, they hope to furnish all other committees with a method of reliable maintenance factors.

Mr. Crouch noted that a revision of the American War Standard on Protective Lighting is underway; that the Textile Lighting Committee will study the basic process of fibres; that the Committee on Defense Coordination will continue to be very active, with indications that the government is especially interested in cooperating with this committee's studies now being made at Tulane University.

I.E.S. Research Fund

Mr. Crouch, as Secretary of the Research Fund, presented in brief the Fund's accomplishments during the past year, indicating several research projects completed and several others well under way.

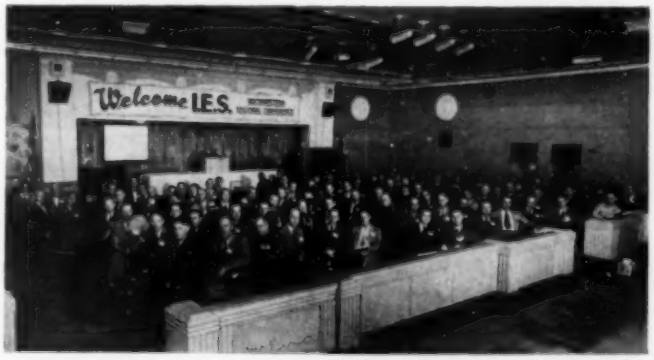
Corpus Christi Host to Southwestern Regional Conference

Technical excellence of the program and desirability of location vied with each other to attract delegates to the Southwestern Regional Conference, held March 4, 5 and 6, at the Driscoll Hotel in Corpus Christi, Texas. Whichever was responsible, the attraction was considerable, something like 206 people being registered.

Traditional procedure for conferences usually calls for technical sessions first, with social receptions on the last day's program. The Southwestern Regional Conference got off to a hospitable start on Sunday afternoon, with the Reception honoring guest-of-honor, President Walter Sturrock, followed by a cocktail party at 6:30 p.m. This feature proved especially successful.

The entire meeting started off with an atmosphere of good fellowship, renewal of acquaintances and the making of new friends. Planners of the Conference attribute the successful progress of the technical sessions to the friendly social opening.

Outstanding speakers, the majority from southwestern states, presented pa-



SOUTHWESTERN Regional Conference, Corpus Christi, Texas, attracted 206 delegates to its three-day meeting, March 4-6.

I.E.S. PRES. Walter Sturrock receives western style belt and purse at Corpus Christi meeting. H. L. Scott, center, and J. M. Williams made presentation.

pers of particular interest to the conference delegates. Details of the papers program are:

SUNDAY, MARCH 4

Registration
President's Reception and Cocktail Hour

MONDAY, MARCH 5

This Conference, Floyd A. Covington, Regional Vice-President
Address of Welcome, Leslie Wasserman, Mayor of Corpus Christi
Report of Regional Vice-President, F. A. Covington
Your Society in 1951, Walter Sturrock, President of Illuminating Engineering Society
Public Building Lighting, Edward Rambusch, Rambusch Decorating Co., New York, N. Y.

Technical Session

Chairman, H. G. Hrivnatz

Evaluation of Lighting Installations, William G. Darley, Darley & Moses, Consulting Engineers, Austin, Texas
X-Factors in Fluorescent Lighting, Benjamin S. Benson, Jr., Benjamin Electric Mfg. Co., Des Plaines, Ill.
A Chance to Play (G. E. Sports Lighting Film), R. M. Eichner, Manager, G. E. Company, Corpus Christi

TUESDAY, MARCH 6

Chairman, Thomas R. Halsey

Lighting for Production and Protection, B. F. Benning, Manager, Lighting Sales, Graybar Electric Company, Dallas, Texas
The Third Dimension in Architecture and Selling, Kurt Versen, President, Kurt Versen Co., Englewood, N. J.
Contemporary Residential Lighting — Brief Illustrated Report of I.E.S. Technical Committee, Miss Estelle Hudson, Dallas Power & Light Co., Dallas, Texas
Luncheon, Dragon Grill
"Lighting Today," Edwin Vennard, Vice-President, Middle West Service Co., Chicago, Ill.

Planned Lighting Session

Chairman, A. R. Kennedy

Report on E.E.I. Planned Lighting Program, A. R. Kennedy, Central Power & Light Co., Corpus Christi, Texas

Examples of Planned Lighting in the Southwest:

Ed. Barry, Arkansas Power & Light Co., Little Rock, Ark.
A. L. Lacey, Central Power & Light Co., Corpus Christi, Texas
R. A. Honsberger, Gulf States Utilities Co., Beaumont, Texas
Harry Hrivnatz, Houston Lighting & Power Co., Houston, Texas

(*Continued on page* 10A)

LIGHTING CALENDAR

Society Events

May 9-12, 1951 — Canadian Regional Conference, Chateau Frontenac, Quebec City, Que.

May 18-19, 1951—Midwestern Regional Conference, Blackhawk Hotel, Davenport, Iowa

May 24-25, 1951 — Great Lakes Regional Conference, Hotel Gibson, Cincinnati, Ohio

June 14, 1951 — Meeting of I.E.S. National Council, New York, N. Y.

August 27-30, 1951 — Illuminating Engineering Society, National Technical Conference, Hotel Shoreham, Washington, D. C.

September 8-13, 1952 — Illuminating Engineering Society, National Technical Conference, Edgewater Beach Hotel, Chicago, Ill.

Industry Events

May 7-9, 1951 — American Public Power Association Annual Convention, Read House, Chattanooga, Tenn.

May 7-9, 1951 — Business Development Section, Northwest Electric Light & Power Association, Multnomah Hotel, Portland, Oregon

May 7-11, 1951 — National Fire Protection Association, Annual Meeting, Hotel Statler, Detroit, Mich.

May 9-11, 1951 — The Engineering Institute of Canada, Annual Meeting, Mt. Royal Hotel, Montreal, Canada.

May 10-11, 1951 — Electrical Contractors Association, Annual Convention, Royal York Hotel, Toronto, Can.

May 10-12, 1951—New York Society of Professional Engineers, Engineering Industries Exposition, Hotel Statler, New York, N. Y.

May 17-19, 1951 — Public Utilities Advertising Association, Hotel New Yorker, New York, N. Y.

May 20-23, 1951 — National Office Management Association, Hotel Commodore, New York, N. Y.

Week of May 20th, 1951 — National Association of Electrical Distributors, Atlantic City, N. J.

May 21-23, 1951 — Missouri Association of Public Utilities, Annual Convention, Jefferson Hotel, St. Louis, Mo.

May 21-23, 1951 — Pacific Coast Electrical Association, Annual Convention, Biltmore Hotel, Los Angeles, Calif.

May 27-30, 1951 — American Society of Refrigerating Engineers, 38th Spring Meeting, Hotel Statler, Detroit, Mich.

May 28-30, 1951 — Conference on Electrical Instrument Design, London, England

May 28 - June 8, 1951 — Canadian International Trade Fair, Toronto, Can.

June 3-8, 1951 — Society of Automotive Engineers, Summer Meeting, French Lick Springs Hotel, French Lick, Indiana

June 4-7, 1951 — Edison Electric Institute, 19th Annual Convention, Denver, Colo.

June 6-16, 1951—British Plastics Exhibition and Convention, National Hall, Olympia, London, England

June 7-8, 1951 — American Management Association Waldorf-Astoria Hotel, New York, N. Y.

June 11-15, 1951 — Second Annual Conference on Industrial Research, Columbia University, New York, N. Y.

June 11-15, 1951 — American Society Mechanical Engineers, Semi-Annual Meeting, Royal York Hotel, Toronto, Canada

June 13-15, 1951 — President's Highway Safety Conference, Interior Auditorium, Washington, D. C.

June 14-16, 1951 — National Society of Professional Engineers, Annual Meeting, Minneapolis, Minn.

June 18-20, 1951 — Annual Convention of the Canadian Electrical Association, Algonquin Hotel, St. Andrews, N. B.

June 18-22, 1951 — American Society for Testing Materials, Annual Meeting, Atlantic City, N. J.

June 25-29, 1951 — Summer General Meeting, American Institute of Electrical Engineers, Royal York Hotel, Toronto, Canada

June 25 - July 4, 1951 — International Commission on Illumination, Stockholm, Sweden

June 30 - July 7, 1951 — New York State Association of Electrical Contractors and Dealers Annual Convention, Saranac Inn, Saranac, N. Y.

July 2, 1951 — International Organization for Standardization, Geneva, Switzerland

July 2-4, 1951 — The American Society of Heating & Ventilating Engineers, Semi-Annual Meeting, Portland, Oregon

August 20-23, 1951 — Pacific General Meeting, American Institute of Electrical Engineers, Multnomah Hotel, Portland, Ore.

September 11-20, 1951 — Building Research Congress, London, England

September 24-27, 1951—32nd Annual Meeting, Institute of Traffic Engineers, Ambassador Hotel, Los Angeles, Calif.

September 25-28, 1951 — Fall Meeting, The American Society of Mechanical Engineers, Minneapolis, Minn.

September 26-28, 1951 — Annual Meeting, Canadian Electrical Manufacturers Ass'n, General Brock Hotel, Niagara Falls, Ont.

October 8-12, 1951 — 39th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

October 9-10, 1951—National Farm Electrification Conference, Hotel Gibson, Cincinnati, Ohio

October 9-12, 1951 — National Electrical Contractors Associations, Annual Convention, Shoreham Hotel, Washington, D. C.

October 15-17, 1951 — International Association of Electrical Inspectors, Southern Section, 23rd Annual Meeting, Hotel John Marshall, Richmond, Va.

October 15-19, 1951 — Fall 1951 Convention of the Society of Motion Picture and Television Engineers, Hollywood-Roosevelt Hotel, Hollywood, Calif.

October 22-24, 1951—33rd Annual Meeting, American Standards Ass'n, Waldorf-Astoria Hotel, New York, N. Y.

October 22-26, 1951 — American Institute of Electrical Engineers, Fall General Meeting, Hotel Cleveland, Cleveland, Ohio

November 12-15, 1951 — National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

November 28-30, 1951 — Annual Meeting, The American Society of Mechanical Engineers, Atlantic City, N. J.

December 2-5, 1951 — American Society of Refrigerating Engineers, 47th Annual Meeting, Hotel Roosevelt, New York, N. Y.

December 5-7, 1951 — Annual Meeting, National Association of Manufacturers, Waldorf-Astoria Hotel, New York, N. Y.

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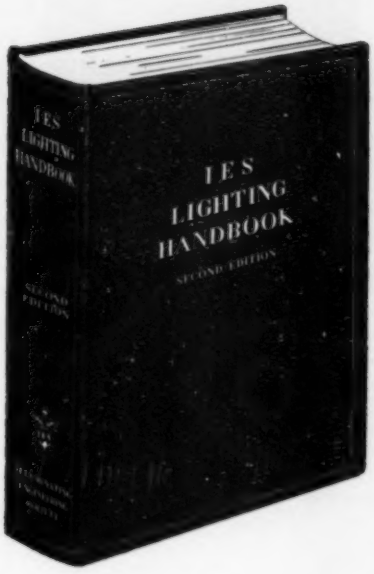

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(*Continued from page 7A*)

James D. Hampton, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Martin J. Myers, Public Service Co. of Oklahoma, Tulsa, Okla.
Floyd Covington, City Public Service Board, San Antonio, Texas
R. K. Lathrop, Southwestern Gas & Electric Co., Shreveport, La.
Andy Anderson, Texas Electric Service Co., Fort Worth, Texas
John Deck, Jr., Texas Power & Light Co., Dallas, Texas
Tom Lynn, Southwestern Public Service Co., Amarillo, Texas
W. E. Folsom, Dallas Power & Light Co., Dallas, Texas

ENTERTAINMENT

Since southern Texas in early March is a good place to have fun, the Conference planners included a share of this in the program. Probably the highlight in the entertainment program was the "Beach Party" given Monday night. This was a buffet dinner and dance held in the Terrace Room of the hotel. The decorative scheme was patterned after a typical beach scene with palm trees, sand and nautical accompaniments. Over 200 people enjoyed this affair.

Climax of the party was the presentation to Walter Sturrock, guest of honor, of a western style belt and purse. The presentation was made by Harry L. Scott of Scott Electric and Engineering Co., and James M. Williams, of Central Power & Light Co., who served as general chairman of the Conference.

Other entertainment features of the three-day meeting included fishing trips on Sunday, sight-seeing trips, and a noonday luncheon on Tuesday planned specially for the ladies.

COMMITTEES

The satisfaction that Corpus Christi and the southwest had contributed much to the Society and to the lighting industry in their area, was the rewarding feeling of the many southwestern members who planned and conducted the conference. Heading the committees who participated were:

GENERAL CONFERENCE CHAIRMAN
James M. Williams, Central Power & Light Co., Corpus Christi, Texas

FINANCE COMMITTEE
Chairman, B. L. Guess, Jr., Guess Electric Co., Corpus Christi, Texas
Co-Chairman, A. D. Tilley, Corpus Christi Hardware Co., Corpus Christi, Texas

PAPER AND PROGRAM COMMITTEE
Chairman, W. E. Folsom, Dallas Power & Light Co., Dallas, Texas
Co-chairman, B. F. Benning, Graybar Electric Co., Dallas, Texas
Co-chairman, Ralph Heitzman, Benjamin Electric Mfg. Co., Dallas, Texas

ATTENDANCE AND PUBLICITY COMMITTEE
Chairman, A. L. Lacey, Central Power & Light Co., Corpus Christi, Texas
Co-chairman, Carlton Whitworth, Central Power & Light Co., Corpus Christi, Texas
Co-chairman, Doris Hall, Central Power & Light Co., Corpus Christi, Texas

M-ORDER regulations were outlined for 174 members at a meeting March 22 sponsored by the Cleveland Section. Guest speaker was Glen Thompson, Chief of Priorities in that region.

M-Order Regulations Outlined at Cleveland Meeting

M-Order regulations was the subject of a special Technical Forum Luncheon sponsored by the Cleveland Section of I.E.S. on March 22 at the Hotel Allerton. Guest speaker was Glen Thompson, Chief of Priorities of the U. S. Department of Commerce, Cleveland Region. In his speech he indicated to the 174 members and guests attending, how to operate under the various M-Order regulations of the government. Special emphasis was placed on M-4 and M-12 as well as the MRO regulations. A few of the important points covered were:

1. Industrial plants may purchase capital equipment up to $750. This equipment is charged against the company's MRO Budget.
2. Commercial stores may modernize up to a total expenditure of $5,000.
3. Department stores and office buildings may modernize up to a total expenditure of 25c per square foot of occupied space.
4. All D.O.-Orders have the same priority whether their number be 1 or 99.

The meeting was felt to be a timely and especially valuable service of I.E.S. to its local members.

ENTERTAINMENT COMMITTEE
Chairman, James B. Murname, General Electric Co., Lamp Dept., Corpus Christi, Texas
Co-chairman, George H. Wilson, Westinghouse Electric Supply Co., Corpus Christi, Texas

HOTEL AND RESERVATIONS COMMITTEE
Chairman, L. O. Dal'as, Central Power & Light Co., Corpus Christi, Texas

RECORD AND CONFERENCE COMMITTEE
Chairman, M. V. Fisk, General Electric Supply Corp., Corpus Christi, Texas
Co-chairman, L. F. Price, Sterett Supply Co., Corpus Christi, Texas

LIGHTING DISPLAY AND DECORATION COMMITTEE
Chairman, A. B. Zepeda, Blucher & Naismith, Inc., Corpus Christi, Texas
Co-chairman, C. W. Matten, Lighting Supply Co., Corpus Christi, Texas

TRANSPORTATION COMMITTEE
Chairman, Ralph E. Broyles, Graybar Electric Co., Corpus Christi, Texas
Co-chairman, C. E. Dudley, Southern Alkali Corp., Corpus Christi, Texas

LADIES' RECEPTION COMMITTEE
Chairman, Mrs. James M. Williams, 453 Atlantic Ave., Corpus Christi, Texas

Iowa Section Holds Spring Conference

The Iowa State College at Ames, Iowa was host to the Spring Conference April 6, one of four such meetings sponsored each year by the Iowa Section of I.E.S. The Spring meeting was organized by D. W. B. Boast of the Department of Electrical Engineering, Iowa State College, a well-known educator in illuminating engineering and active member of I.E.S. Some 54 members traveled by rail and auto to attend the meeting.

The program included an afternoon inspection of the new Electrical Engineering Building at the college, and a series of demonstrations in the Illumination Laboratory, conducted by James W. Nilsson and Prof. R. W. Ahlquist.

A dinner meeting, held in the new dining room of Memorial Union was followed by a lecture "Engineering Prob-

(*Continued on page 13A*)

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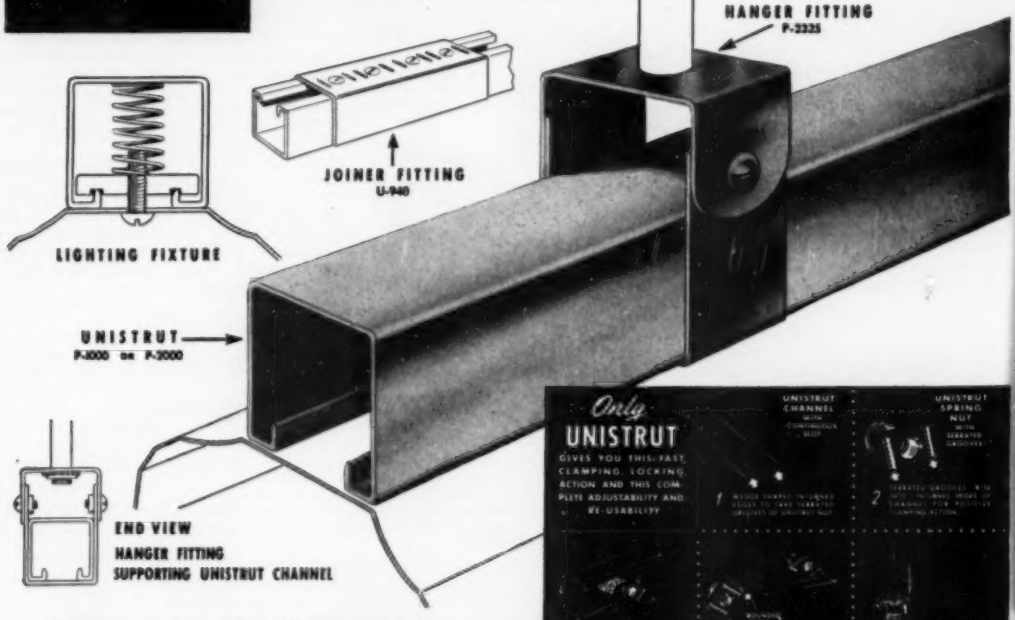

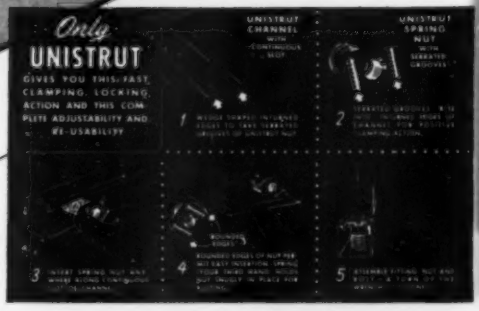

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All of these, and many other conditions for proper lighting of defense plants can be met through the specification of RLM-Labeled Lighting Units. All units bearing the RLM Label are warranted by Electrical Testing Laboratories to conform to the minimum standards established by the RLM Standards Institute for efficiency, durability and uniform quality.

FREE RLM BOOKLETS containing complete specifications for all RLM-Certified Industrial Fluorescent and Incandescent Lighting Units and the names of all manufacturers of RLM-Labeled Units may be obtained by writing: RLM STANDARDS INSTITUTE INC., Suite 823, 326 West Madison Street, Chicago 6, Illinois.

Specification of RLM-Labeled Units Assures Conformance to ALL these Essentials of Defense Production Lighting

DIFFUSION WITH HIGH REFLECTION FACTOR
RLM Porcelain-Enameled Steel Reflectors must have a mean reflection factor of 82% . . . an assurance of more light for the money. Porcelain enamel reflecting surfaces *diffuse* light from the lamp and help provide proper *quality* of illumination.

TOP QUALITY PORCELAIN-ENAMELED REFLECTORS
RLM Reflectors are built of not less than .032" reflector steel covered with .025" fused on porcelain enamel that will not chip, corrode or deteriorate under industrial operating conditions.

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Reflector design of RLM Units conforms to specifications embodying approved practices of illuminating engineering.

HIGH POWER FACTOR BALLASTS
RLM Standards specify the use of certified ballasts which last longer, because they are designed to prevent excessively high temperature operation.

UNIFORM QUALITY
RLM Standards insist on the maintenance of uniform quality as to materials and construction, thus assuring the buyer of uniform lighting performance from each unit installed.

RLM STANDARDS INSTITUTE

(Continued from page 10A)

lems in Atomic Energy" by Dr. Adolph Voigt, Ames Laboratory of the Atomic Energy Commission.

Chester P. Stone of Waterloo, Vice-Chairman of the Iowa Section, presided over the successful meeting in the absence of Dean Barnhizer, Section Chairman.

Floodlighting Design Course Held in Western N. Y. Section

A series of five demonstration lectures devoted to a study of floodlighting equipment and its application was sponsored jointly by the I.E.S. Western New York Section and the University of Buffalo February 26 through March 26. Basic design methods were presented to enable the solution of the usually encountered floodlighting jobs. Some 22 students enrolled for the course from various branches of the electrical industry in Western New York.

Subjects of the five lectures included:

"The Design and Characteristics of Floodlights." Reflector contours and materials; open, enclosed and sealed beam types; candlepower distribution and beam spread.

"Basic Calculations for Any Floodlighting Application." Relation of beam spread and projection distance; area coverage and illumination.

"Floodlighting of Storage Yards, Parking Spaces and Outdoor Work areas." Location of Projectors; reducing glare; equipment selections based upon life of installation; maintenance.

"Floodlighting of Recreation Areas, Bulletin Boards and Buildings."

"Floodlighting for Protection," and "Special Uses for Searchlights."

HEADLINING events at the Pacific Northwest Regional Conference — l. to r., I.E.S. President Walter Sturrock, G. C. Tenny, editor of *Electrical West*, Blair E. Plowman, and Dave Moses, Co-Chairmen of the meeting, Ken Hollingsworth, Regional V-P, W. C. Hird, Chairman of I.E.S. Inland Empire Chapter. The successful conference attracted some 200 lighting men from northwest US and Canada.

"Lighting in the West" Featured at Regional Conference

The Pacific Northwest demonstrated, by the response to its I.E.S. Regional Conference, that it is still one of the most progressive sections lighting-wise in the country. Some 200 people, from half a dozen states and Canada, attended the meeting March 22 and 23 at the Davenport Hotel in Spokane, Washington. The Inland Empire Chapter was host, with all of the Sections and Chapters comprising the Region well represented.

The success of the meeting was not happenstance. Careful planning and organization were given to every detail, from the excellent technical program developed, well designed notices mailed at intervals, and organized committee direction, through to guest entertainment and delegate registration. Local public interest in the meeting is exemplified by the some 60 column inches of newspaper coverage given to the Conference by Spokane papers.

Judging from the emphasis given various subjects by the newspapers, top public interest was shown in industrial lighting, color, school lighting, and new developments.

As will be noted from the program detailed below, leading speakers from all parts of the country participated in the papers sessions. Included were:

MARCH 22, 1951

Morning Session

Chairman, W. C. Hird, Inland Empire Chapter

"Lighting in the West; Past, Present and Future," George C. Tenney, Editor and Publisher of *Electrical West*.

"New Developments in Glass," Harold G. Vogt, Research Physicist, Corning Glass Works.

Afternoon Session

Chairman, J. G. Galarneau, Oregon Section

"Lighting for Defense Industry," Benjamin S. Benson, Chief Illuminating Engineer, Benjamin Electric Manufacturing Company.

"Lighting for Agriculture," C. M. Cutler, General Electric Company.

Cocktail Hour — Hall of Doges, Davenport Hotel.

President's Banquet honoring I.E.S. President Walter Sturrock.

(Continued on page 14A)

Business Directory of I.E.S. Membership

An accurate up-to-date business directory of the entire membership of the Illuminating Engineering Society has been compiled under the direction of the Publications Committee to be available only to members of the Society. Copies of the directory, 6 x 9 inches in size, may be obtained from I.E.S. headquarters at $2.00 for single copies, or $1.75 each for quantities of ten or more.

Orders should be addressed to:

ILLUMINATING ENGINEERING SOCIETY
Publications Office
1860 Broadway
New York 23, N. Y.

(Continued from page 13A)

MARCH 23, 1951

Morning Session

Chairman, H. A. Gardner, Puget Sound Section

"Color in the Coordinated Classroom," John Marshall Ziv, Luminall Paint Company.
"School Auditorium and Stage Lighting," C. M. Cutler, General Electric Company.

Afternoon Session

Chairman, R. M. Campbell,

British Columbia Section

"Review of Highlights in Fluorescent Lighting Progress," T. C. Sargent, Sylvania Electric Products Inc.
"Lighting in Canadian Churches," Walter Lind, Canadian General Electric Company.

Another important feature of the Conference was the Officers Breakfast held Saturday morning at the Davenport Hotel, Spokane. This meeting enabled the officers of the Sections and Chapters of the Pacific Northwest Region to meet with I.E.S. President Walter Sturrock for important discussions of local and national I.E.S. affairs.

COMMITTEES

The smooth operation of the Conference was due to much good work by many local members. Directing their efforts were: Blair E. Plowman and Dave Moses who served as joint Chairmen of the Conference; Dave Parker, Program and Papers; A. B. Godfrey, Registration and Reception; Walter Toly, Entertainment; William Newman, Hotel and Properties; George I. Morrison, Publicity; John Ruffatto, Finance; Mrs. Walter Toly, Mrs. Carl L. Hoffman, Mrs. Dave Moses, Ladies Program Committee.

AT THE SPEAKERS' TABLE for the presentation of its charter to the Mexico Chapter are Edmundo Morales Silva, Chairman of the Chapter; National President Walter Sturrock; Jose Carlos Silva, Secretary of the Mexico Chapter; and Doctor Luis Sanches Bulnes, Director of the Association to Avoid Blindness in Mexico. The presentation was made March 7.

Charter Presentation Made To Mexico Chapter

Newest of the chapters of I.E.S. is the Mexico Chapter, whose Charter was presented March 7 by President Walter Sturrock. Mr. Sturrock was welcomed by Mr. A. Celis, President of the Mexican Lighting Institute, and then spoke to the chapter on "The I.E.S., Its Organization, Constitution and By-Laws." Edmundo Morales Silva accepted the Charter and a beautiful gavel, which was the gift of the Northwestern Ohio Chapter, next "youngest" I.E.S. group.

The connection of lighting specialists with oculists and the need for cooperation to work for standardization of lighting levels in working areas was the subject of a speech by Daniel Silva, vice-president of the Mexican Ophthalmological Association.

ANNUAL joint dinner meeting, So. Calif. Section of I.E.S. and the American Institute of Architects held at the Mona Lisa Restaurant, Los Angeles, March 13. Attendance of 160 included 65 Architects and 95 I.E.S. members. Speaker Walter Sturrock, President of I.E.S. on subject "Lighting for Better Living." Following main talk was panel discussion "Point vs Line, vs Area Light Sources." The Engineer's viewpoint was taken by J. S. Hamel, Consulting Electrical, Mechanical, and Illuminating Engineer. The Architect's viewpoint was taken by Maynard Lyndon, Architect.

New England Section Holds Street Lighting Course

The New England Section conducted a comprehensive course in street lighting for the employees of the Boston Edison Co., February 27 through March 15. The course was organized by the Section's Educational Committee headed by Henry Klopot, at the request of the utility. To meet the increased postwar interest in street lighting in the New England territory, plus the development of new equipment and techniques, the Boston Edison Co. felt the need for a "refresher course" for the many employees in its Sales, Engineering and Distribution Departments who had some responsibility for street lighting. To provide such a review of street lighting fundamentals they asked I.E.S. in New England to prepare a program and take over active direction.

Some 50 persons attended the course. While the majority were Boston Edison employees, neighboring utilities of the New England power system and Cambridge Light Co. were invited to partici-

(Continued on page 18A)

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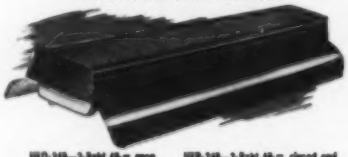
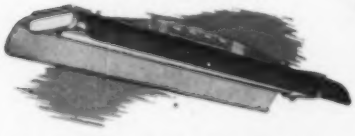


SUD-248—2-light 48-w. open
SUD-348—3-light 48-w. open
SUD-2-148—2-light 100-w. open
SUP-248—2-light 48-w. closed end
SUP-348—3-light 48-w. closed end
SUP-2-148—2-light 100-w. closed end

Durable and strongly built fixtures, neat in appearance. All-steel housing, channel and reflectors. On continuous run wireway installations 2-light sections may be grouped with 3-light or blank sections. One-piece channel for twin 40-watt sections (8' length) or 100-watt sections (10' length).

ZEPHYRLITE SERIES



ZUD-248—2-light 48-w. open
ZUD-348—3-light 48-w. open
ZUP-248—2-light 48-w. closed end
ZUP-348—3-light 48-w. closed end

Corrugation incorporates unusual strength and rigidity into units. No warping, twisting or sagging! All-steel housing, reflectors, deep drawn channel. 2-light units can be easily converted to 3-light whenever desired. For individual or continuous run wireway installation.

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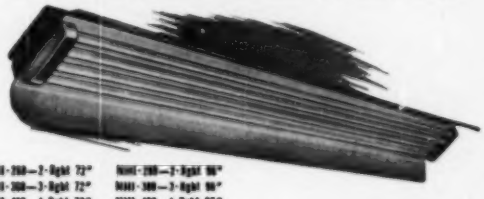
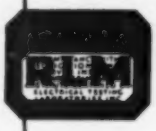


NHU-248—2-light 72"
NHU-348—3-light 72"
NHU-448—4-light 72"
NHU-296—2-light 96"
NHU-396—3-light 96"
NHU-496—4-light 96"



These heavy-duty Slimline fixtures bring streamlined styling to industrial lighting and provide exceptionally high light intensity. All-steel channel and reflectors. Designed primarily for continuous run wireway installations. Instant-start operation in choice of 120, 200, 300 or 425 ma. Multi-bulb units for up to 10 lamps available on special order.

Leader

Sold and installed by better electrical dealers and contractors everywhere.

America's No. 1 Lighting Equipment Manufacturer

LEADER ELECTRIC COMPANY

3500 North Kedzie Avenue • Chicago 18, Illinois

Leader Electric—Western: 800 One Hundredth Avenue • Oakland 3, California
Campbell-Leader, Ltd.: Brantford, Ontario • Canada

inductive circuits

how to select the proper switch for fluorescent lamp loads

Any electric circuit that includes an electro-magnetic device, such as a fluorescent lamp ballast, is an inductive circuit and *The National Electrical Code* requires:

"Switches controlling inductive loads shall have an ampere rating twice the ampere rating of the load, unless of a type approved as part of an assembly or for the purpose employed."

To determine the switch rating for a fluorescent lighting load, add together the primary current values marked on each ballast in the circuit and multiply the resultant figure by two.

EXAMPLE:

What switch should be used to control a fluorescent lamp circuit comprising 4 lighting fixtures, each fixture having 4—40-watt lamps operating from two 2-lamp ballasts?

ANSWER:

The primary current (normal line amperes) marked on the 2-lamp ballast is 0.85 and as there are 8 ballasts, the total line current would be 0.85 x 8, or 6.80 amperes. Multiply this value by two—6.8 x 2 = 13.6 amperes. Therefore a 20 ampere rated switch should be used.

FOR EXACTING LOADS

Bryant offers the following lines of 20 and 30 ampere flush switches designed to handle severe loads in industrial and commercial installations.

THE ANSWER IS BRYANT

No. 5861

20 ampere
Bakelite Enclosed Cup
1-15/32" deep
Single Pole
Double Pole
3-Way

No. 5421

20 ampere
Bakelite Enclosed Cup
1-15/16" deep
Single Pole
Double Pole
3-Way, 4-Way

No. 3971

20 ampere
Grey Porcelain Cup
1-1/2" Deep
Single Pole
Double Pole
3-Way, 4-Way

No. 5431

30 ampere
Bakelite Enclosed Cup
1-15/16" deep
Single Pole
Double Pole
3-Way, 4-Way

Listed as Standard by Underwriters' Laboratories, Inc.

BRYANT
SUPERIOR WIRING DEVICES

THE BRYANT ELECTRIC COMPANY

Bridgeport 2, Connecticut

CHICAGO • LOS ANGELES

3-00854

(Continued from page 14A)

pate. A number of representatives of street lighting equipment manufacturers also attended.

The two-hour lectures, in six weekly sessions, were extremely well done. So successful was the operation that the Section is now considering adopting such a course as a regular I.E.S. program, offered for the benefit of anyone interested, particularly those people in municipalities responsible for street lighting. Details of course included:

1. *The What and Why of Good Street Lighting* — by S. R. Williams, Holophane Co. Inc.
   A discussion of the objective of street lighting—silhouette vision, glint, pavement brightness, direct vision, how to minimize glare, etc. The part of the I.E.S. Street and Highway Lighting Code. The reasons for good street lighting.
2. *Fundamentals of Street Lighting* — by P. N. Clerke, Westinghouse Electric Corp.
   Nomenclature—the termino'ogy of street lighting. Demonstrations of principles of light control. How to read and interpret the various data and curves of street lighting.
3. *Layout Principles*—by P. N. Rutherford, General Electric Co.
   Types of lighting distribution; pole spacing; bracket lengths; mounting heights. Relating distribution curves to brightness patterns, footcandle levels, etc.
4. *Special Situations in Street Lighting* — by R. M. Swetland, General Electric Co.
   Bridges, curves, under-passes, etc. Police and forestation. Low-mounted sources. Tunnel entrances. Special colors.
5. *Available Equipment* — by J. S. Young, New England Power Co.
   A discussion of typical features of available equipment, emphasizing the characteristics which help to achieve lighting essentials, good maintenance in service, and other goals.
6. *Standardization of Street Lighting Equipment* — by W. H. Edman, Line Material Co.
   Reference EEI and NEMA Standardization of street lighting equipment.

Sixteen Foreign Members Elected This Year

To date, since the start of the fiscal year October 1, sixteen people from twelve different countries have been elected to membership in the Illuminating Engineering Society. Total foreign membership in the Society is some 187 members from all parts of the world. Those elected in this year so far are:

Centano V., Melchor, Prof. — Caracas, Venezuela, S. A.
Chowdhry, Sourindra Nath — Calcutta, India
Cruz, Cipriano — Manila, Philippines
Clerckx, H. — Antwerp, Belgium
Del Corral, Alberto — Bogota, Colombia, S. A.
Dines, Ronald W. D. — Grays, Essex, England
Ferrier, Malcolm V.—Harrow, Middlesex, England
James, K. G. — Singapore, Malaya
Maisonneuve, J. — Paris, France
Makower, G. — Buenos Aires, Argentine
Mejia, F. — Medellin, Colombia, S. A.
Mounter, Francis W. — Singapore, Malaya
Prieto Urioste, Carlos — Santiago de Chile, Chile
Quesada N., J. Roberto — Guatemala, Rep. of Guatemala
Van Wamelen, M. A. — Curacao, N. A.
Wyborn, E. J. — Boxmoor, Herts, England

New Lighting Handbooks Won In I.E.S. Exhibit Raffle

Five utility people visiting the E.E.I. Sales Conference in Chicago April 2-5, each won a prize copy of the brand new IES Lighting Handbook now being prepared.

A raffle awarding copies to five winners was a feature of the Society's exhibit at the Conference headquarters.

One of the many "I.E.S. Dividends" featured by the exhibit, the new IES Lighting Handbook will be awarded to:

L. O. Buckner, Metropolitan Edison Co., York, Pa.
Don Bootes, Dayton Power & Light Co., Dayton, Ohio
W. B. Bertolet, Metropolitan Edison Co., Easton, Pa.
J. A. Mahr, Indianapolis Power & Light Co., Indianapolis, Ind.
R. K. Lothrop, Southwestern Gas & Electric Co., Shreveport, La.

The new book, a completely revised edition of the lighting industry's most valuable reference book, is expected to be off the press October 1, 1951.

Analysis Shows Value Of Association Activities

The value of trade association activities, particularly to small business, is brought out in an analysis of trade associations entitled "Association Activities," published recently by the Chamber of Commerce of the United States.

The report, the first comprehensive one of its kind issued since prior to World War II, was prepared by Milton A. Smith, assistant manager of the Chamber's Trade Association Department.

The range of association services is shown to be broad, varying with the characteristics of the industry served. Four of the more important activities common to most such organizations are designed to:

1. Promote efficiency in production and distribution through technical research voluntary standardization, improved accounting methods, and other means.
2. Create goodwill for and better understanding of the industry's products or services.
3. Develop new materials and products, and new uses for old products.
4. Provide information and representation in relations with government, employees and the public.

The foregoing activities are pointed to as of special benefit to smaller concerns, along with other identified as insurance services and traffic transportation information.

Trade associations, the report points out, are universally conscious of the importance of gearing their programs so they will be in the public interest. Examples of such an attitude are reflected, says the report, in efforts to conserve raw materials, particularly natural resources, and activities in relation to public health and safety.

Single copies of this booklet are available free. For quantity prices please write the Chamber of Commerce of the United States, 1615 H Street, N. W., Washington, D. C.

From *Nema News*, Vol. 18, No. 3.

MEMBERS of the Twin City Section of I.E.S. had a first-hand view of how specialty lighting fixtures are created during Section inspection meeting at plant of Burnham, Mareck & Duepner. Some 70 members attended. Shown are l. to r. O. Fox, R. D. Coons, W. T. Mareck, L. E. Johnson, I. Schmuck, E. V. Bergstrom, N. Knafla.

Cornhusker Chapter Features All-Day Meeting

A full-scale lighting conference was sponsored by the Cornhusker Chapter of I.E.S. March 30, at the Rome Hotel, Omaha, Nebraska. An excellent technical program featuring outstanding lecturers was presented, arranged by the Chapter's Program Chairman, Ford Bates.

With Chapter Chairman Ed Taber presiding, the conference program, starting at ten in the morning and continuing throughout the evening, featured:

Address of Welcome, by F. J. Moylan, Asst. Gen. Mgr., Omaha Public Power District.

The Development of Visual Performance, by G. N. Getman, O.D., Secretary, Missouri Valley Optometric Society

Luncheon

Protective Lighting, by R. R. Engleman, Lighting Engineer, Westinghouse Electric Corporation, Lighting Division

Home Lighting Recipes, by Dorothy Blade, Home Lighting Specialist, Omaha Public Power District

Basis for Lighting Design, by J. M. Ketch, Lighting Design Specialist, G. E. Lighting Institute

Panel Discussion

The Effect of Artificial Lighting on the Human Eye and on the Human Being—Prof. V. L. Hollister, Moderator, Electrical Engineering Department, University of Nebraska

J. M. Ketch, Lighting Design Specialist, G. E. Lighting Institute

Prof. G. H. Sechrist, Instructor in Illumination, University of Nebraska

G. N. Getman, O.D.

Social Hour — Entertainment Committee in charge

Dinner — Marchil's Steak House, 4443 South 13th Street

Omaha Sports & Vacation Show, Omaha Auditorium

New American Standard Projects Underway

Of several projects now in process by the American Standard Association, according to a recent list in *Standardization*, the following standards may be of interest to the lighting field:

Protective Lighting for Industrial Properties, A 85, Sponsor: Illuminating Engineering Society

Electrical Measuring Instruments, C 39, Sponsor: Electrical Standards Committee

Electrical Insulating Materials in General, C 59, Sponsor: American Society for Testing Materials

Measurement of Test Voltage in Dielectric Tests, C 68, Sponsor: American Institute of Electrical Engineers

Standards for Motion Pictures, PH 22, Sponsor: Society of Motion Picture and Television Engineers

Letter Symbols and Abbreviations for Science and Engineering, Z 10, Sponsor: American Society of Mechanical Engineers

Definitions of Electrical Terms, C 42, Sponsor: American Institute of Electrical Engineers

Dates of issue have not yet been established. Further information on any of these projects may be obtained from the American Standards Association, 70 East 45th St., New York 17, N. Y.

NORTHERN California Section meeting March 14 featured I.E.S. President Walter Sturrock as guest speaker. Section officers and prominent members seated across head table are l. to r. Prof. L. H. Brown, Stanford U.; William Major; Sol Cohn, Section Chairman; President Sturrock; Carl Martin, Regional V-P; Dan Finch; Francis Falge. Photo courtesy of *Electrical West*.

Newsletter Published by Chicago Lighting Institute

No. 1, Vol. 1 of an interesting Newsletter devoted to lighting activities has just been launched by the Chicago Lighting Institute, 37 S. Wabash Ave., Chicago 3, Illinois. Except for the summer months, the publication is planned for monthly distribution. Editors of the paper are Philip C. Sowersby and Carl W. Zersen.

The first issue, a five-page mimeographed letter, reports on Institute activities for the first quarter of 1951. Subsequent issues will report and review news items of interest to all groups of the electrical and lighting industries.

Color Problems in Camouflage

Color problems in camouflage are being studied by the Engineer Research and Development Laboratories at Fort Belvoir, where spectral reflectance and wave length of colors are found to be as important as the color itself. Projects involving surface appearance include camouflage coloration of combat uniforms and appearance characteristics of camouflage nets and garnishing materials. Plastics are being investigated as a replacement for burlap, with embossing, flocking and creping being investigated as means of eliminating surface gloss. Details of the project are available upon request to: Technical News Letter, Room 2C-765, Pentagon, Washington, D. C.

IT SEEMS TO ME

Plastic Ceilings

To the Editor:

It seems to me that D. H. Tuck's letter in the March 1951 IE (page 10A) indicates that he is prejudiced against luminous ceilings in general and Dr. Spencer in particular.

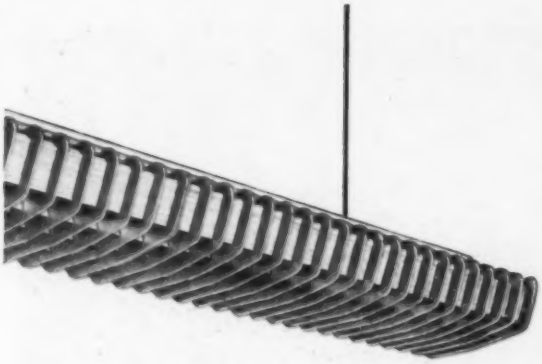
I would like to inform Mr. Tuck that coefficients of utilization of the order of 0.687 as claimed by Dr. Spencer can be obtained with luminous ceiling lighting, a fact which we have verified by test. In order to have a high utilization coefficient with bare lamps, the cavity shape must be good and have a high reflectance. If the cavity has a large number of obstructions or if its surfaces cannot be maintained with a high reflectance then the use of industrial reflectors will still provide a high coefficient of utilization.

It would appear that the examples quoted by Mr. Tuck as having coefficients of utilization of 0.225, 0.20 and 0.10 are poorly designed installations or are erroneously reported.—H. F. DAVIDSON, *620 University Ave., Toronto, Canada.*

To the Editor:

Replying to Mr. Tuck's letter on page 10A, March issue of ILLUMINATING ENGINEERING, there seems to be some slight errors in arithmetic. In the first place, the cost of the Barbadoes ceiling was $6.28 per sq. ft, and not $10. Second the total area of 2800 sq. ft. is lighted by

(Continued on page 23A)



THERE'S ONLY ONE WAY TO GET COMPLETE LIGHTING SATISFACTION

Only one way — QUALITY EQUIPMENT. It is the economical way, too. That is why it is best to specify Miller lighting equipment. It is built on an 8-Point standard of quality construction, with engineering features that minimize cost of installation and maintenance.

Thousands of installations, in stores, offices, schools, factories and public buildings, have proven the enduring QUALITY of Miller lighting equipment, and its LOW OVERALL COST — cost of equipment, installation and maintenance — the important point to be considered in planning lighting.

For complete lighting satisfaction, SPECIFY MILLER — one source of supply for QUALITY equipment for the best use of Fluorescent, Incandescent, and Mercury-vapor lighting. Developed on a background for 107 years pioneering and progress in Good Lighting.

Miller field engineers and distributors are conveniently located for nation-wide service.

THE miller COMPANY MERIDEN, CONN.
SINCE 1844

ILLUMINATING DIVISION: Fluorescent, Incandescent, Mercury Lighting Equipment
HEATING PRODUCTS DIVISION: Domestic Oil Burners and Liquid Fuel Devices
ROLLING MILL DIVISION: Phosphor Bronze and Brass in Sheets, Strips and Rolls

Better Ballasts Mean Better Lighting

For more light per lamp, more light per watt make sure your fixtures are *powered* by General Electric Fluorescent ballasts.

QUALITY COSTS LESS

Fluorescent lamps are designed for starting and operating at specific values of electrical power. When these values are accurately maintained by a quality ballast, the ratio of light output to power input is high —you save money because the lamp is operating at peak efficiency. Improper operation with a poor ballast means *lower* light output, and *shortened* lamp life.

HOW QUALITY BALLASTS SAVE YOU MONEY

More light output from fixtures powered by G.E. Ballasts means initial investment is less to obtain the same level of light. Longer lamp life means a yearly saving on maintenance and replacement costs. More efficient operation means a saving in power costs for the same light output.

ASK FOR THIS TAG ON THE FIXTURES YOU SPECIFY. It is your assurance of ballast quality. It means you are specifying a fixture made by a fixture manufacturer who builds with the best. General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

412-91

CROUSE-HINDS High Efficiency LIGHTING EQUIPMENT...

Type EVF Explosion-Proof and Dust-Tight
Fluorescent Lighting Fixtures
1, 2, 3, or 4 -Lamp

. . for Hazardous Locations

Crouse-Hinds explosion-proof lighting fixtures exceed the requirements for service in highly explosive atmospheres. They are designed to operate at a temperature below the ignition temperature of the gas-air or vapor-air mixture. They are so strong that they will resist internal explosions without damage and so tight that they will prevent the escape of flames or burning gases which might ignite the surrounding atmosphere.

Crouse-Hinds dust-tight lighting fixtures assure safety in locations that are hazardous because of the presence of combustible dust.

. . . for Wet and Corrosive Location

Crouse-Hinds vaportight lighting fixtures are ideal for use in boiler rooms, powerhouses, shower rooms, tunnels, loading docks, building entrances, and all indoor and outdoor locations where exposed to moisture and rain, non-explosive vapors and gases, or non-combustible dusts.

Hundreds of industrial lighting fixtures are listed in Crouse-Hinds Condulet Catalog.

. . . for Protection

Sabotage thrives in darkness. The most reliable and cheapest form of protection against night prowlers is LIGHT! Crouse-Hinds floodlights project powerful beams of light that bathe all approaches to your property with glaring radiance, killing darkness and shadows and compelling everyone to be more visible at night than in broad daylight.

The protective power of light should be used in all important municipal and industrial locations. The floodlighting of industrial plants serves a double purpose. It helps to boost production in addition to the security it provides.

Send for your copy of Bulletin 2565, "LIGHT! Protect Your Property."

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

Offices: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas
Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Milwaukee
Minneapolis — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco
Seattle — St. Louis — Washington. *Resident Representatives:* Albany
Atlanta — Baltimore — Charlotte — New Orleans — Richmond, Va.
CROUSE-HINDS COMPANY OF CANADA, LTD., TORONTO, ONT.

CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

(Continued from page 19A)

192 cold cathode lamps rated at 1800 lumens (E.T.L.).

A little calculation will show that the utilization factor (including depreciation) is 20.8% assuming that his reading of 15 footcandles is correct. The utilization was calculated at 20%. Actually, his readings were taken before the construction was complete and there was a layer of cement dust on the panels which was not removed until after the contractor had left. As a matter of record, the illumination fell from 48 to 35 footcandles in six months.

This installation was so satisfactory that two similar rooms have been so equipped; one at Richmond Station, and one at Conowingo. The latter is replacing a glass artificial skylight, installed when the station was built. This type of illumination is not a sure-cure for all diseases. Under certain conditions it may well be the best solution. — ARTHUR A. BRAINERD, *Philadelphia Electric Co., Philadelphia, Pa.*

I.E. Readership

To the Editor:

Concerning at least one point of the comments of Mr. Dan Dunne as published in the February issue of ILLUMINATING ENGINEERING, we who are charged with having to determine readership of the official publication have a few notes to add for the information of IE readers.

Mr. Dunne is perfectly safe in attributing a 5% member readership index to the old Transactions because he knows as well as we do that no such study was ever made by the publisher or anyone else in its first 45 years of existence. Not until the past two years (since January 1949 when the format was enlarged, the subject matter improved and extended, and advertising pages added) have such studies been attempted. However, figures now available show a considerably different percentage of reader interest than Mr. Dunne expressed. Mr. Dunne may recall that the information following has been in his hands or file for some time.

A survey of replies from members *only* in September 1950 showed that 69% of the members (readers) performed one or more "action" steps in reading the *advertising*. Translating this percentage to "reader activity." assuming a certain percentage to have read only the editorial text pages, would indicate a "reader" index of 90%, based on accepted publishing standards.

Two comparative surveys were made by other sources; one in May 1949 by an advertiser of lighting equipment; another in May 1950 by a widely read and recognized publication in the electrical field. In neither case were we aware the surveys were being made until they were completed.

The first such survey made in May 1949 by an independent research group for a prominent lighting equipment manufacturer, classed IE *first* among a list of 12 well known national publications serving the lighting field and general business. Leading utilities' lighting departments were the group questioned. IE ranked first with 275 votes over the second publication with 104 votes and a third with 45 votes. Both "2" and "3" are leading papers in the electrical field. The same respondents found IE advertising pages most useful in keeping them

(Continued on page 24A)

Interesting Installations in Vancouver, B. C.

Installation	Address	Type of Lighting
Chapman Ltd. Store	633 Granville	Translucent plastic louverall
Hudson's Bay Co. Store	Granville & Georgia	Combination fluorescent and incandescent surface louvered sections
Tip Top Tailors, Store	314 W. Hastings	Louverall adjustable floods and atmosphere lighting
Sweet Sixteen Ltd. Store	319 W. Hastings	Direct incandescent plus fluorescent wall case lighting
Cunningham Drug Stores Ltd.	2803 W. B'way	All types
Tobans Drugs	B'way & Commercial	Fluorescent & incandescent
Woodwards West Vancouver Store	Marine Dr. & Taylor Way—W. Vancouver	All types
Jordans Ltd., Store	2546 Granville	Direct incandescent
Speiser Furs	2706 Granville	Special effect lighting
"41" Grill, Restaurant	Granville	Cove lighting
Bank of Montreal	Granville & Pender	Fluorescent flush louver units
John Oliver High School	500 Blk. E. 41st	Fluorescent & incandescent classroom lighting
Cambie Street (St. Ltg.)	12th to 25th Aves.	Incandescent units
Columbia Street (St. Ltg.)	New Westminster	Mercury lighting
Stanley Park Tennis Courts	Stanley Park near English Bay Ent.	Floodlighting—coin meter operated
British Car Center, Showroom	4th Ave. & Yew	Luminous ceilings
Black Motors, Showroom	Dunsmuir & Homer	Luminous ceilings
McDonald's Prescriptions, Store	925 W. Georgia	Continuous row fluorescent prismatic glass lens type units
McGill & Orme Ltd., Store	627 Fort St. (Victoria, B. C.)	Cove & Troffer
The Stork Shop	631 Fort St. (Victoria, B. C.)	Troffer & Niche
George Straight Ltd., Store	921 Government St. (Victoria, B. C.)	Troffer & Cove
Christ Church Cathedral	Georgia & Burrard	1000 W. lanterns (incandescent)
Lost Lagoon Fountain	Georgia St. Entrance to Park	Fountain illuminated at night
U.B.C. War Memorial Gym.	University Hill	Recessed incandescent
Vancouver Art Gallery	1145 W. Georgia	Combination recessed slimline and incandescent

Compiled by British Columbia Section, I.E.S.

(Continued from page 23A)

informed about new lighting products and new lighting developments, placing IE first with 247 votes; second and third positions having 177 and 69 votes.

The second survey made in May 1950, again among utility personnel, was made by another publication. IE ranked third in being read regularly and second as to being found most useful in the respondents' work. Incidentally, IE placed first as to its usefulness to those who read it regularly, despite its third position in being read regularly. Over 30 publications of all types—business, general and news—were named by respondents.

Naturally we have not available readership indexes on all of the magazines named in these two surveys. In addition to the proof provided by our own survey, it can be safely assumed that Mr. Dunne's 5% readership figure is very, very low. For his further satisfaction, let Mr. Dunne watch closely the letters which appear in "It Seems to Me" and the amount of discussion published on various papers and articles in ILLUMINATING ENGINEERING. There is no better index of reader interest and activity short of actual survey.

Mr. Dunne has a reputation among lighting people for seeking the facts and figures about any project in which he takes part. Here they are.—CLAYTON E. ELLIS, *Advertising & Promotion Manager, I.E.S. Headquarters.*

ABOUT PEOPLE

The retirement, after more than thirty years of service, of **A. Hadley Taylor,** physicist on the engineering department staff of General Electric's Lamp Division at Nela Park, has been announced. Mr. Taylor specialized in the field of lighting research and pioneered in collecting data on the color properties of light sources and materials. Among the numerous instruments and meters developed by Mr. Taylor for accurate measurement of radiant energy are various types of reflectometers, brightness meters, the germicidal watt meter, and a portable setup for the rapid graphic measurement and recording of street illumination. In recent years he has engaged in important researches in short-wave ultraviolet energy.

Harold G. Cheney, Westinghouse sales executive, has been appointed headquarters administrator of lamp sales for the company. Mr. Cheney will continue to make his headquarters in Bloomfield, N. J.

John H. Ronayne of the commercial department of Edison Electric Institute has been appointed manager of the Better Light Better Sight Bureau in New York. He succeeds **Glen R. Trumbull,** who headed it from its beginning in 1934 until his retirement late in 1948.

Erne C. Carlson has been named by the Administrative Committee of the National Electrical Contractors Association as president of that organization, to fill the unexpired terms of Edward Vanderlinde, who died last month. Mr. Carlson has been connected with the electrical contracting industry for fifteen years and is widely known for his work in labor relations.

William G. Darley, consulting engineer and fellow of I.E.S., has been appointed editor of *Southwest Electrical Industry.* Mr. Darley was connected with the General Electric Company for sixteen years, and since 1947 has been established as consulting engineer in Austin, Texas, specializing in lighting, ultraviolet and infrared applications.

The Rohm and Haas Company announces the appointment of **Frederick W. Tetzlaff** as assistant to the vice-president in the production department. Mr. Tetzlaff was previously in charge of sales development for the acrylic plastic sheet and molding powders.

The Lighting Sales Central Division of Sylvania Electric Products Inc. has been reorganized into three separate divisions for the Chicago, St. Louis and Milwaukee areas. **W. J. Rashleigh, Myles Gaythwaite** and **Paul T. Owens** will head these offices.

Four regional managers of manufacturing have been assigned by Westinghouse Electric Corp. to nine plants for production of light bulbs. **Matthew Westphal** has been appointed manager of lamp plants in Bloomfield and Trenton, N. J.; **William J. Williams** as manager of parts plants in Bloomfield and Belleville, N. J. and at Paris, Texas, where ground has just been broken; **Elwood W. Noxon** as manager of lamp plants at Richmond and Bowling Green, Ky., and Little Rock, Ark.; and **James E. Woodall** as regional manager at Fairmont, W. Va.

Harry Handler, president of General Lighting Co., Inc., has been appointed manufacturers' representative for the Sunbeam Lighting Co. of California in the territory comprising New York, New Jersey, Eastern Pennsylvania and New England.

Fred C. McMillan, head of the Electrical Engineering Department, Oregon State College, has been nominated for the 1951-52 presidency of the American Institute of Electrical Engineers.

NEW MEMBERS

At the meeting of the Council Executive Committee held in New York City, April 5, 1951, the following were elected to membership:

BRITISH COLUMBIA SECTION

Associate Member:
Hutchinson, G. W., Canadian Laco Lamps Ltd., Vancouver, B. C.

CAROLINAS CHAPTER

Associate Members:
Crenshaw, William, Sylvania Electric Products, Inc., Alexandria, Va.
Furman, C. M., Jr., Charles M. Furman, Jr. & Associates, Charlotte, N. C.
Harkey, Martin L., Jr., General Electric Co., Charlotte, N. C.

CENTRAL NEW YORK CHAPTER

Associate Members:
McNulty, William, Jr., Graybar Electric Co., Inc., Syracuse, N. Y.
Roy, James, Oneida Ltd., Oneida, N. Y.
Wyland, G. B., Oneida Ltd., Sherrill, N. Y.

CHICAGO SECTION

Members:
McDonald, L. E., Sylvania Electric Products, Inc., Chicago, Ill.
Seitz, R. J., Public Service Co. of Northern Ill., Northbrook, Ill.
Associate Members:
Archer, M. B., Lustra Corp. of America-Brooklyn, Chicago, Ill.
Hennes, Jacob, Kubec Electric Co., Chicago, Ill.
Linton, J. R., Sylvania Electric Products, Inc., Chicago, Ill.
Orsi, J. E., Sylvania Electric Products Inc., Chicago, Ill.
Smith, Clarence, Smith Electric Shop, Dwight, Ill.
Trullson, Neal, General Electric Company, Chicago, Ill.
Wrobel, L. H., Compco Corp., Chicago, Ill.
Student Members:
Keesecker, R. D., University of Illinois, Urbana, Ill.
Porello, A. C., Jr., University of Illinois, Urbana, Ill.

CLEVELAND SECTION

Associate Member:
Barna, George, Jr., Westinghouse Electric Corp., Cleveland, Ohio

CONNECTICUT SECTION

Associate Member:
Savoie, L. E., Hubbard, Lawless & Blakeley, New Haven, Conn.

EASTERN PENNSYLVANIA CHAPTER

Member:
Roth, B. F., Pennsylvania Power & Light Co., Allentown, Pa.
Associate Member:
Schwenk, P. H., Raub Supply Co., Lancaster, Pa.

FLORIDA CHAPTER

Associate Member:
Best, B. P., Florida Power Corp., Clearwater, Fla.

FOREIGN NON-SECTION

(The name of Ronald W. D. Dines, Benjamin Electric Ltd., Brantwood Rd., Tottenham, London, England was inadvertently left out of this listing last autumn.)

GEORGIA SECTION

Associate Members:
Arnold, A. M., Senior Fluorescent Inc., Atlanta, Ga.
Miller, H. D., General Electric Co., Atlanta, Ga.
Myers, Miss Naomi, Southern Engineering Co., Atlanta, Ga.

(Continued on page 41A)

MITCHELL

module still America's NO.1 Commercial Lighting

REG U S PAT OFFICE

20% more light!

Yes, MITCHELL MODULE is *still* unequalled for effective light output, unequalled because inch for inch it delivers *more* light per operating dollar than any other louvered commercial fixture. MODULE's exclusive Polystyrene plastic louver passes 20% MORE LIGHT than conventional metal louvers—saves more lighting dollars in *every* installation.

50,000 ways to get it!

And MITCHELL MODULE is *still* the *only* lighting system that *custom-fits any installation with standard low-cost units.* With just 4 simple, inexpensive "building blocks of light," MODULE creates *unlimited* custom-fitting lighting patterns. Because MODULE units fit together simply (both mechanically and electrically) patterns can be rearranged to meet changing needs—*at minimum cost.*

MODULE's styling is enduring; stays beautiful, new. No ordinary fixtures can match MODULE—*still* the *only* lighting system that delivers *20% more light* and *custom-fits* any commercial interior at *lowest operating cost.*

only MITCHELL *makes* MODULE

MITCHELL MANUFACTURING COMPANY
2525 N. Clybourn Avenue • Chicago 14, Illinois
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from everyone's viewpoint...

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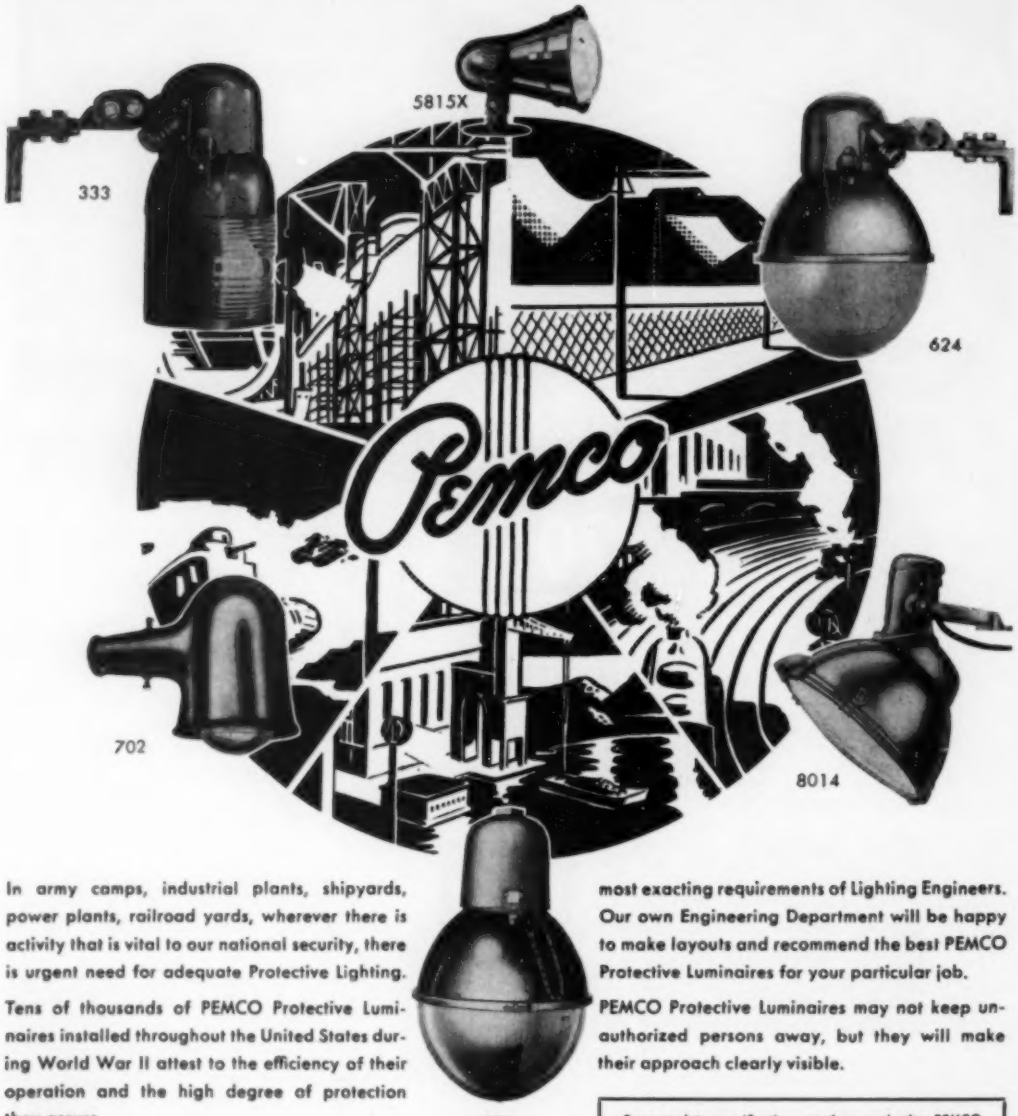
FOCUS *Pemco* LUMINAIRES ON THE DANGER SPOTS



In army camps, industrial plants, shipyards, power plants, railroad yards, wherever there is activity that is vital to our national security, there is urgent need for adequate Protective Lighting.

Tens of thousands of PEMCO Protective Luminaires installed throughout the United States during World War II attest to the efficiency of their operation and the high degree of protection they assure.

Regardless of the size or location of the vital area, you will find PEMCO Luminaires to meet the most exacting requirements of Lighting Engineers. Our own Engineering Department will be happy to make layouts and recommend the best PEMCO Protective Luminaires for your particular job.

PEMCO Protective Luminaires may not keep unauthorized persons away, but they will make their approach clearly visible.

For complete specifications on these and other PEMCO Protective Luminaires refer to your copy of Pemco General Catalog 90. If you do not have a copy on file, please request one.

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The Wakefield Star and Commodore both have translucent Plaskon reflectors which completely shield the lamps and, when the lamps are lit, have about the same brightness as the ceiling above. This is a basic requirement of supplementary lighting systems for co-ordinated classrooms.

To Light a Co-ordinated Classroom

you need a luminous indirect fixture like the

Wakefield { STAR *(fluorescent)* / COMMODORE *(incandescent)*

1. Only a luminous indirect fixture like the Wakefield Star or Commodore will provide smoothly distributed, well balanced light, free from glare and sharp brightness contrasts.

2. Only a luminous indirect fixture like the Wakefield Star or Commodore will create three-dimensional seeing conditions by making the ceiling the primary light source, with the fixture itself and the side walls becoming a secondary source.

3. Only a luminous indirect fixture like the Wakefield Star, which has a minimum of opaque cross-section and a maximum of translucency, will permit fullest transmission of upward beams of daylight from directional glass block.

Our new 20-page book, "Supplementary Lighting for the Co-ordinated Classroom", deals simply but comprehensively with modern classroom lighting. For your copy, write to The F. W. Wakefield Brass Company, Vermilion, Ohio.

Wakefield Over-ALL Lighting

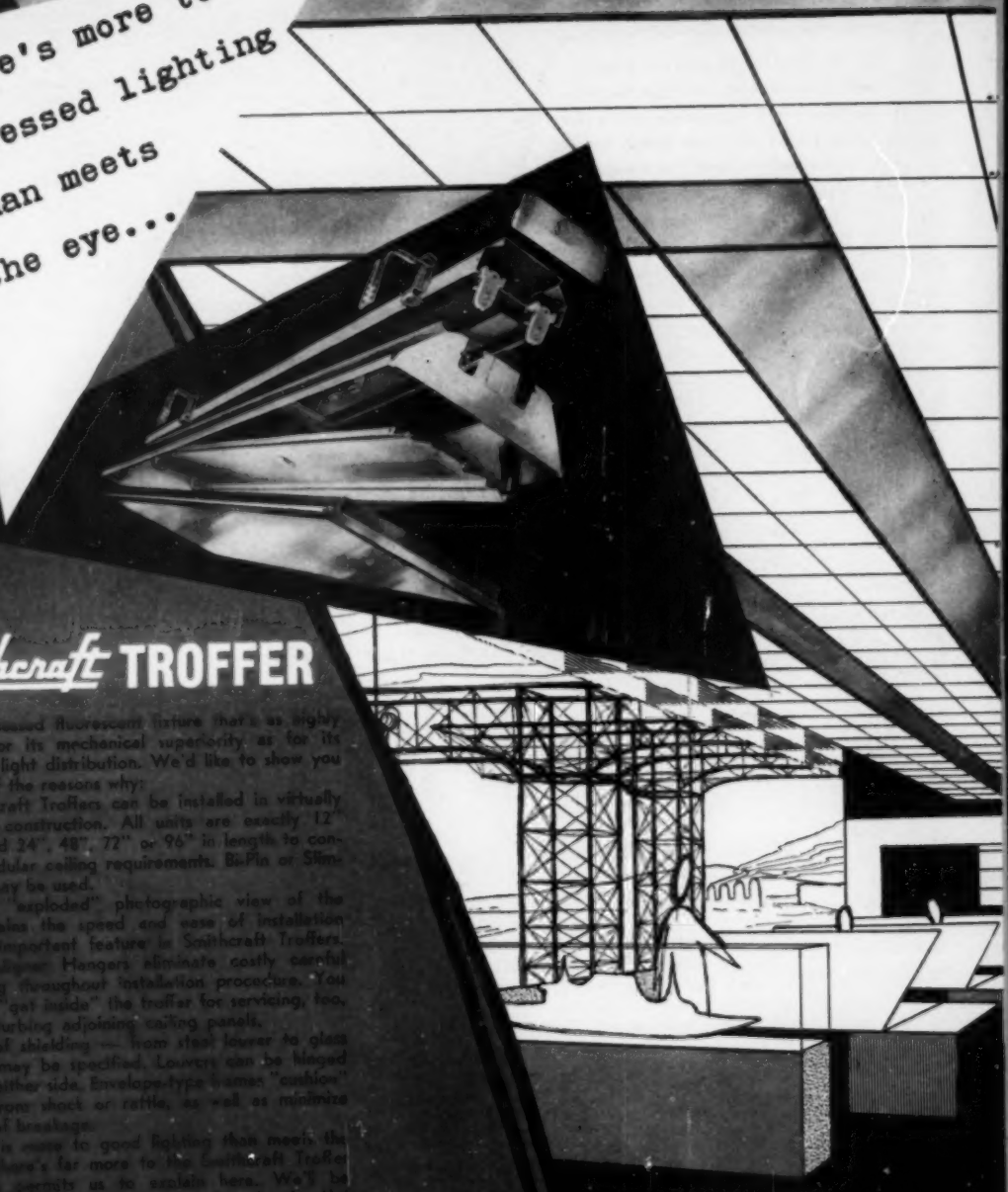
BASIC FOR CO-ORDINATED CLASSROOMS

THE COMMODORE

THE STAR

THE WAKEFIELD CEILING

there's more to recessed lighting than meets the eye...



Smithcraft TROFFER

...re's a recessed fluorescent fixture that's as highly ...claimed for its mechanical superiority as for its ...surpassed light distribution. We'd like to show you ...t a few of the reasons why:

...et, Smithcraft Troffers can be installed in virtually ...y ceiling construction. All units are exactly 12" ...width, and 24", 48", 72" or 96" in length to con...rm to modular ceiling requirements. Bi-Pin or Slim... ...lamps may be used.

...e above "exploded" photographic view of the ...ffer explains the speed and ease of installation ...is an important feature in Smithcraft Troffers. ...ented Allgrip Hangers eliminate costly careful ...mentlining throughout installation procedure. You ...n always "get inside" the troffer for servicing, too, ...thout disturbing adjoining ceiling panels.

...Any type of shielding — from steel louver to glass ...ay lens — may be specified. Louvers can be hinged ...open from either side. Envelope-type frames "cushion" ...the glass from shock or rattle, as well as minimize ...possibility of breakage.

...There is more to good lighting than meets the ...eye. And there's far more to the Smithcraft Troffer ...than space permits us to explain here. We'll be ...glad to fill in the details. Send for the booklet ..."Architectural Troffers" today!

We'd like to send you our popular monthly house organ "The Light Side of the News". Drop us a line . . . we'll do the rest. We'll be glad, too, to send you a complete Smithcraft Catalog upon request.

America's finest fluorescent fixtures for offices that run the nation's industries...

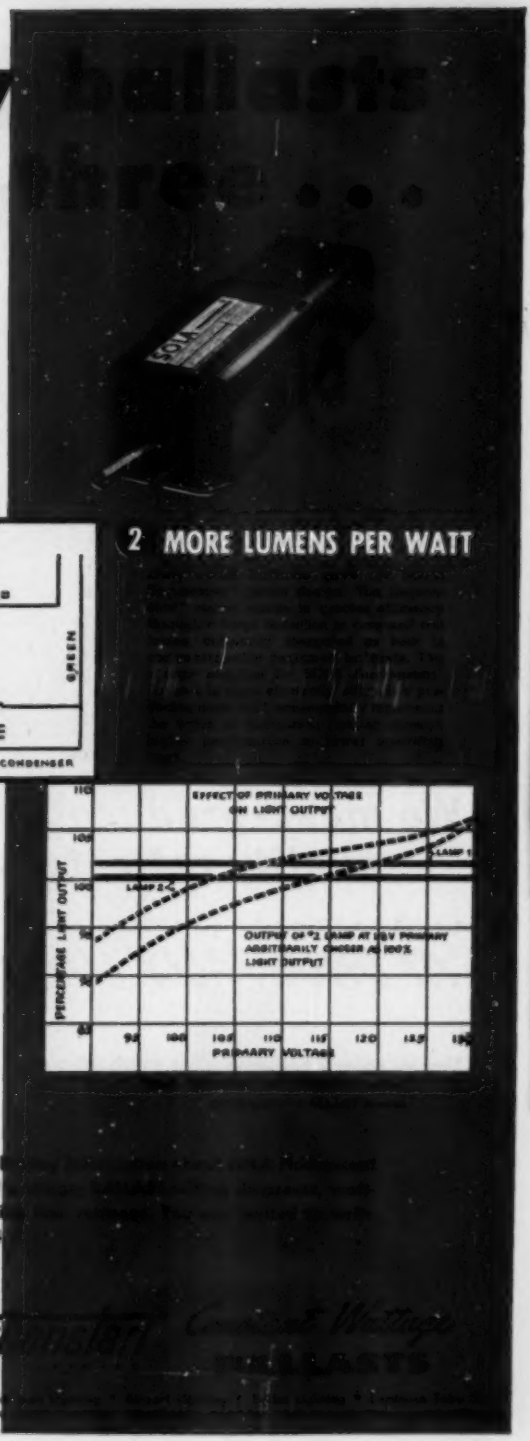
Smithcraft

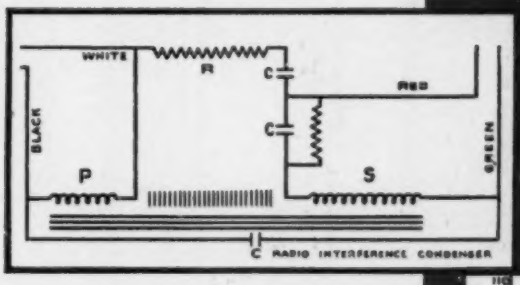
LIGHTING DIVISION

the only ballasts with all three . . .

❶ COOLER OPERATION

Only SOLA Ballasts have the patented ventilated capacitor compartment. The temperature rise on the condenser of the SOLA Sequenstart* Ballast 608-407, for example, is only 18°C. This exceptionally low temperature is due to the insulating action of the ventilated capacitor compartment which isolates the core structure and capacitor with a buffer of circulating air. Cooler operation greatly prolongs ballast life by practically eliminating capacitor failures.





❸ CONSTANT LIGHT OUTPUT

Only SOLA Ballasts have the patented constant wattage resonant circuit. Light output will not vary with line voltage fluctuations when fluorescent luminaires are equipped with SOLA Constant Wattage Ballasts. They deliver a constant supply of energy to the lamps within ±1.5% regardless of line voltage variations from 100-130 volts. This exclusive SOLA constant wattage characteristic is based on the famous patented SOLA Constant Voltage Principle.

*Made under one or more of the following patents: 2,143,745; 2,212,198; 2,346,621 and patents pending.

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Lamp Ballasts: LAMP size, current and
age loss, and dimensions; and operati
for a copy. Request Bulletin C-PFL-144

SOLA Sequenstart Constant Wattage BALLASTS

Transformers for: Constant Voltage • Fluorescent Lighting • Cold C
Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc.

We mass-produce quality reflectors

AT UNUSUALLY LOW COST!

You see above a production line which delivers 700 finished fluorescent reflectors per hour—5000 per shift!

You also see an opportunity—

For here are modern facilities that offer you a new source of high-quality, fluorescent reflectors—of *any* type—at the savings made possible only by these mass-production techniques.

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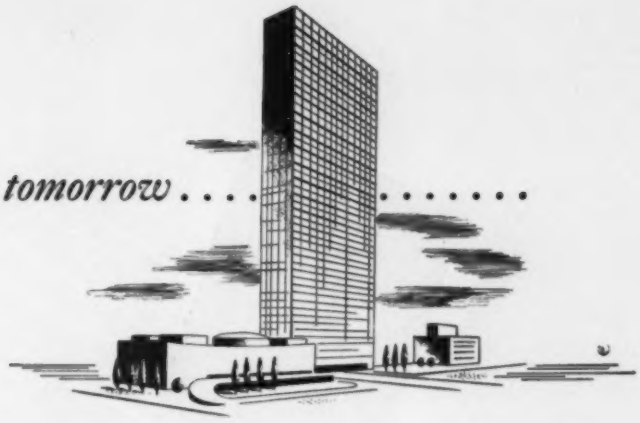
We'll do it any way you want: the complete fabricating and enameling of reflectors, or the enameling of shapes furnished by you. The finished product always meets the exacting standards of the RLM Institute.

These cost-saving facilities are available to you *now!* For complete information write: Lighting Division, Clyde Porcelain Steel Corporation, Clyde, Ohio.

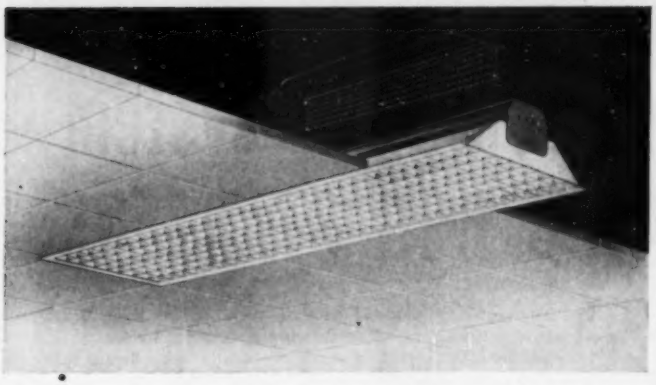
CLYDE PORCELAIN STEEL CORPORATION

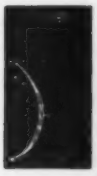
THE NATION'S LARGEST INDEPENDENT PORCELAIN FINISHING PLANT

for a brighter tomorrow . . . .



The permanent home of the United Nations stands as a guiding beacon for world peace. We take great pride in having been selected to manufacture lighting fixtures for every room in the project. Included in this group of luminaries is the functionally designed, custom engineered UNL 503-40, illustrated below. Our many years of intensive research in recessed lighting has produced this unit which features low brightness, high efficiency, and is designed for simple installation and maintenance. The last word in modern troffer lighting, the UNL 503-40 is recommended for every commercial need – for all planned lighting programs.





UNL fixtures are available in 2, 3, and 4-light fluorescent and 2, 3, and 4-light four and eight foot slimlines in all MA ratings. These fixtures are adaptable for use with louvres, Albalite glass, and all types of flat and curved Holophane Controlenses*. Highlighting is achieved with recessed spotlights in either continuous runs or individual mounts.
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Protect your fluorescent system—specify WATCH DOG STARTERS

Look for this new tag on fixtures equipped with Watch Dogs.

Attractive fixtures . . . planned installation . . . correct lighting . . . top-notch working conditions—that's modern fluorescent lighting. But these advantages are often cancelled out when failing lamps begin blinking.

Avoid this after-installation trouble just as surely as you plan for the proper light level—by making sure your fixtures are equipped with General Electric Watch Dog* starters.

These glow-switch starters cut dead lamps out of the circuit as soon as flicker appears and help maintain steady continuous lighting. Watch Dogs prevent unnecessary heating of ballasts because they don't attempt to re-start burned-out lamps.

You'll find it pays to make G-E Watch Dog starters a specification "must." Make them a part of your plans from now on. **Section Q56-587,** Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

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GENERAL ELECTRIC

PUBLICATIONS *of the*
ILLUMINATING ENGINEERING SOCIETY

These publications summarize the studies and conclusions of technical committees of the Illuminating Engineering Society over a period of years. They contain the latest available information about many aspects of the art and science of illumination and include details of application as well as lighting technique. Each publication listed here carries the authority and approval of the Society.

These Society publications are available in single copies for information and for lighting reference book shelves or in quantity for educational or other distribution. Each publication is numbered for ordering when using the coupon printed on the back of this page.

(1) I.E.S. LIGHTING HANDBOOK

One volume, 850 pages. A complete reference guide providing basic information on all phases of lighting. For architects, designers, engineers and others who plan, install and manufacture lighting systems and equipment. $7.50 per copy; $5 in lots of 10 or more.

I.E.S. Members who have not availed themselves of the privilege of one membership copy at $5 may still do so. Add 50c if for shipment abroad.

(See Page 8A)

I.E.S. APPROVED LIGHTING PRACTICES

These booklets contain the latest official I.E.S. lighting recommendations; illustrated with charts, sketches and photographs.

(2) HOME LIGHTING Recommended Practice (1947)

(3) OFFICE LIGHTING Recommended Practice (1947)

(4) STREET AND HIGHWAY LIGHTING American Standard Practice (1947)

(5) LIGHTING PRACTICES FOR STORES AND OTHER MERCHANDISING AREAS (1948)

(6) SCHOOL LIGHTING American Standard Practice (1948)

(7) LIBRARY LIGHTING Recommended Practice (1950)

(8) DAYLIGHTING Recommended Practice (1950)

Booklets above available at 50 cents per copy or in quantity as follows: first 4 copies, 50c each; next 20, 25c each; all over 24 copies, 15c each.

(9) INDUSTRIAL LIGHTING American Recommended Practice (1948)

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LIGHTING IN INDUSTRY

Lighting recommendations based on recent studies (research, surveys of current practice, and experimental installations) of the I.E.S. Committee on Lighting Study Projects in Industry; completely illustrated. Contain analyses of seeing tasks; recommended quality and quantity of lighting; and suitable lighting methods and systems for both general and supplementary lighting.

(10) LIGHTING FOR WOOLEN AND WORSTED TEXTILE MILLS (1949)

Detailed treatment of lighting for opening and grading, carding, spinning, weaving, and perching. Much of data is also applicable to other types of textile mills.

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Revision of the 1939 report. Analysis of factors affecting visibility of convex scales, steel rules, scribed marks, center-punch marks, concave specular surfaces, plane and convex surfaces; general shop lighting; and supplementary lighting for various measuring instruments, bench work, machine tools, and inspection of polished surfaces.

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Close-up photos of visual tasks and levels and quality of illumination for roll, sifter and purifier floors; packing areas; and product control stations.

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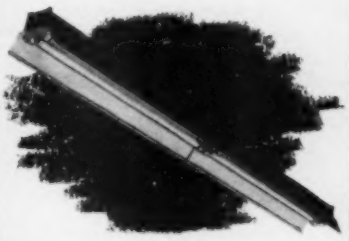

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FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS

RECOMMENDED COMBINATION
For Lighting Heavy-Industry Plants

HOLOPHANE Lighting Equipment and MERCURY Lamps

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(Mills, motor rooms, shops and warehouses)

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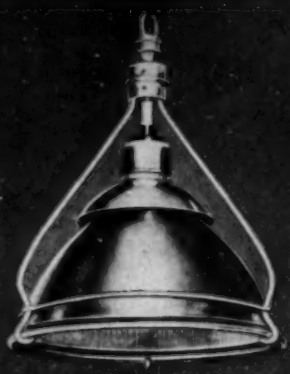
NO. 690-AL-HS—400 Watt E-H1 lamp
400 Watt J-H1 lamp (color corrected)

NO. 698-AL-HS—1000 Watt A-H12 lamp
(Also available for 500–750–1000 Watt incandescent lamps)

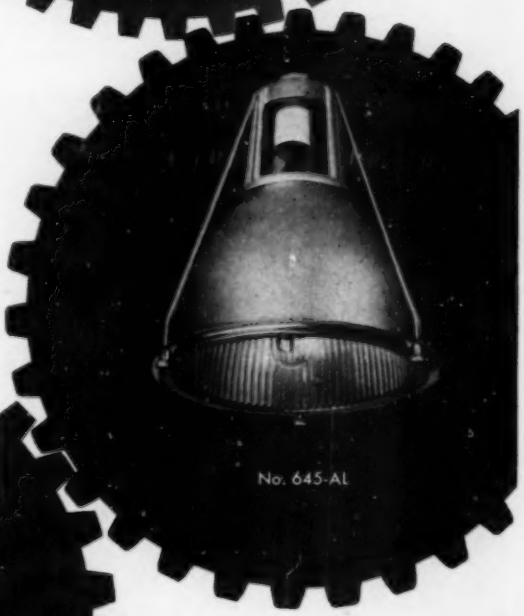
These units are available in HI-STRESS* Glass



No. 693-AL-HS

LOW BAY LIGHTING
(Wire drawing, bench work, inspection, stock rooms, etc.)

NO. 645-AL—400 Watt A-H1 lamp
400 Watt J-H1 lamp (color corrected)
(Also available for 500 Wa t incandescent lamp)



No. 645-AL

OUTDOOR LIGHTING
180° LATERAL SPREAD
(Blast Furnaces, Coke Ovens, Roadways, Parking Lots and other outdoor areas.)

NO. U-850—400 Watt E-H1 lamp
(Also available for 500–750–1000 Watt incandescent lamps)

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Mercury lamps offer economy advantages in steel mills due to high lumen per watt output, long life and efficient reflectors.

400 Watt E-H1 lamps, 20,000 lumens
400 Watt J-H1 lamp (color corrected), 19,000 lumens
1000 Watt A-H12 lamp, 57,000 lumens
(For comparison 1000 watt incandescent lamp gives 21,000 lumens)

No. U-850

Based on the economical operation of these mercury lamps in combination with 1000 watt incandescent lamps or as mercury alone Holophane has developed HIBAY* LOBAY* and Outdoor Lighting Equipment designed for the severe conditions typical of steel mills and other heavy-industry plants. Twin and triple units are also available.

Holophane
*Reg. U. S. Pat. Off.

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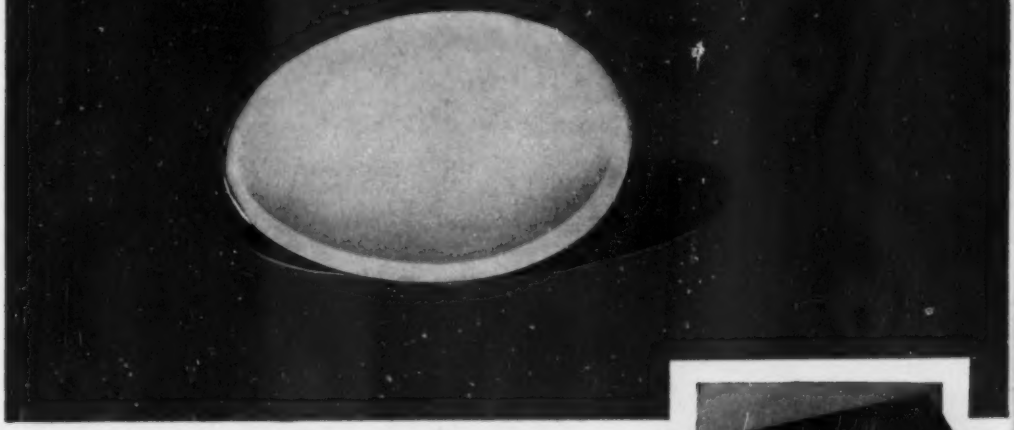
THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO*

LIKE AN EGG



It's What's Inside That Makes The Difference

• The theory of ballast design is well known . . . but the engineering skill and ability — the experience gained through the production of millions of ballasts — the adaptability to *exactly* meet requirements — the control of manufacturing steps — all these determine what you find inside the ballast case.

Inside the case of every Jefferson Electric Ballast you will find incorporated to the highest degree the art of efficient ballast engineering, with all that a generation of specialized experience and manufacturing can provide. Make Jefferson Ballasts your original and replacement specification.

JEFFERSON ELECTRIC COMPANY
Bellwood, Illinois
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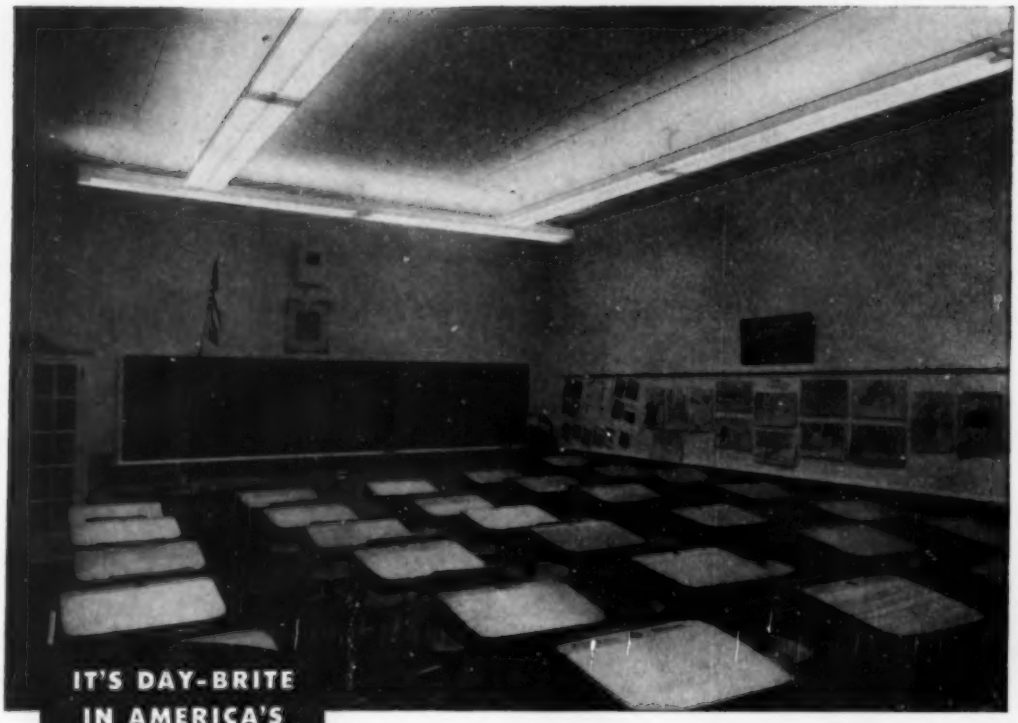
Jefferson Ballasts are constructed to give long-life performance with minimum maintenance. All materials used are of a selected high quality determined by the Jefferson Research Laboratory. All raw materials — insulation, copper wire, electrical steel, receive frequent tests to guard and maintain Jefferson standards. In addition, chemical engineers personally supervise all vacuum impregnation, moisture proofing compounds, and heat treatments. These precautions, plus the liberal design and unexcelled workmanship, assure efficient and maximum ballast service.

BALLASTS



Anyone Can See Why Children Learn in this School

The North Glendale School in Glendale, Missouri is still another school, one of hundreds throughout America—where Day-Brite supplies modern efficient lighting.

Do teachers in your school look at a group of young *squinting* faces? Do your classrooms have a last row problem? Are your blackboards "glareboards"? Then you should do something about your school lighting now. Glare, bright reflected light, sharp color contrasts or insufficient light can cause permanent damage to strained eyes . . . does result in nervous tension and retarded learning.

Day-Brite has conducted scientific school lighting tests for years. That's why they have been able to solve school lighting problems for teachers, school principals and Public School Systems in literally hundreds of America's schools. That's why Day-Brite fixtures give classrooms the glare-free, evenly distributed light that students need. And, that's why Day-Brite has been able to design quality fixtures with the low-cost installation and maintenance features which most school budgets require. Would you like further information? Write today to Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis, Mo.

NOW, MORE THAN EVER

AMERICA MUST SEE WHAT IT'S DOING

IT'S EASY TO SEE WHEN IT'S

"DECIDEDLY BETTER"
DAY-BRITE
Lighting Fixtures

133

How the PC Vision-Lighting Plan helps your lighting scheme

Today, in defense industries, as well as in schools, factories, stores and homes, up-to-date lighting is vitally important. The †PC *Vision-Lighting Plan* complements your electric lighting plan by making the most of daylight. And, as indicated in the two typical installations here, it is a practical plan for *all* sections of the country.

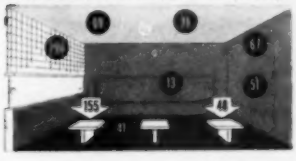
PC *Functional* Glass Blocks create comfortable, low-brightness ratios and adequate illumination levels during daylight hours, conforming to illuminating engineering and architectural standards. To users, they offer other important advantages, too. For they have more than twice the insulating value of ordinary, single-glazed windows. They involve no periodic puttying and painting. And they stop the infiltration of dust and dirt, shut off distracting views.

Why not fill in and return the coupon below for complete information on the use of PC Glass Blocks in industrial, commercial and public buildings?

TYPICAL DAYLIGHTING PERFORMANCE IN ACTUAL INSTALLATIONS

The following "on-the-job" readings from widely-separated communities, are typical of PC Vision-Lighting Plan installations. Continual checks are made of product performance in the field to supplement tests conducted on PC Functional Glass Blocks at the Pittsburgh Corning Daylighting Research Center, Port Allegany, Pa., and independent research laboratories.

ILLUMINATION FROM SKY AND CLOUDS (NO SUN)

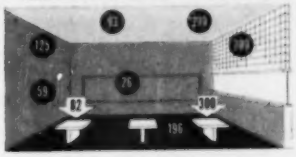


Carthage Junior-Senior High School, Carthage, Texas
Architect: Preston M. Geren, Fort Worth, Texas

Classrooms: 22' x 29' 8", with 11'10½" ceiling.
156 sq. ft. glass block panel (28.4% of floor area).
73 sq. ft. vision sash (11.1% of floor area).

North room (see sketch): PC Prism A Glass Blocks used.
Illumination of panels: 1330 footcandles. Canopy shaded vision strip.
Surface reflectances: Ceiling, 74%; walls, 70%; chalkboard, 18%; tackboard, 32%; floor, 30%.

ILLUMINATION FROM SUN, SKY AND CLOUDS



Willamette School, Willamette, Oregon
Architect: Donald W. Edmundson, Portland, Oregon
Associate Architect: Neil R. Kochendoerfer, Portland, Oregon

Classrooms: 23' x 49', with 12'2" ceiling.
102 sq. ft. glass block panel (10.2% of floor area).
86 sq. ft. vision sash (8.6% of floor area).

Southeast room (see sketch): PC Soft-Lite B 55 Glass Blocks used.
Illumination of Panels: 5500 footcandles. Sun altitude, 27° to 30°; sun azimuth, minus 62° to minus 34°.
Canopy shaded vision strip.
Surface reflectances: Ceiling, 73%; walls — upper 70%, lower, 50%; chalkboard, 30%; tackboard, 30%; floor, 40%; desk tops, 45-30%.

● = Average brightness in foot-lamberts
◇ = Average illumination in footcandles

† The PC *Vision-Lighting Plan* is a construction for daylight openings consisting of orientation-keyed areas of PC *Functional* Glass Blocks (selected for sun or non-sun exposure) used with vision-ventilation areas as required.

PITTSBURGH CORNING CORPORATION
PITTSBURGH 22, PA.

PITTSBURGH PC CORNING

GLASS BLOCKS
The mark of a modern building

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Dept. Q-51, 307 Fourth Avenue
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Without obligation on my part, please send me your FREE booklet on the use of PC Glass Blocks in industrial, commercial and public buildings.

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Address.....
City.....State.....

Distributed by Pittsburgh Plate Glass Company; W. P. Fuller & Co. on the Pacific Coast; Hobbs Glass Ltd. in Canada; and by leading distributors of building materials everywhere.

For Distinctive Shadowless Lighting . . .

CORNING FOTA-LIGHT

There's no denying the dramatic effect of a completely luminous ceiling whether for executive offices, stores, or commercial buildings. But, it must also be functional—provide a high level of illumination with low panel brightness. The unique properties of Corning Fota-Lite make it perfect for this type of lighting.

Fota-Lite gives you all the advantages of louvered lighting and flat glass combined. Vertical light is almost unrestricted, yet the diffusing louvers keep brightness level low—give the glass the appearance of plain opal. Non-color selective, Fota-Lite gives better quality light—transmits the true color of the light source.

Strong, light in weight and free of warpage, Fota-Lite is easily installed in shallow, dust-tight fixtures. And, unlike usual louvering materials, Fota-Lite can be cleaned with the wipe of a cloth—does not change color, scratch or attract dust. Available in widths up to 24″ and lengths up to 100″, Fota-Lite may be used in almost any application where louvering is desired.

A remarkable new lighting medium, Fota-Lite controls the 45° cutoff by louvers photographically produced in a thin (½″) panel of glass. The tiny opal louvers are part of the glass itself —will not deteriorate with age or weathering—save metals—lower maintenance costs.

CORNING GLASS WORKS, CORNING, N. Y.

Corning means research in Glass

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(*Continued from page 24A*)

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(*Continued on page 43A*)

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with a NEW HEAVY-DUTY

SLIMLINE INDUSTRIAL UNIT

- LOWER SURFACE BRIGHTNESS
- HIGHER LUMEN OUTPUT
- LONGER LAMP LIFE
- INSTANT LIGHT *WITHOUT* STARTERS
- LIFETIME PORCELAIN ENAMEL

THESE CONSTRUCTION FEATURES TELL THE STORY!

SILV-A-KING RLM

- Newly designed one-piece, heavy gauge steel top channel. Individual mounting or continuous runs. Finished in gray baked-enamel to match top side of reflector. Immediately available in 8 ft. units — will be available in 4 and 6 ft. units.
- Slide-grip hanger groove running entire length of unit permits wide versatility of installation.
- Lifetime porcelain-enamel reflector, white inside, gray outside.
- New E-Z-LOK for split second assembly or disassembly of reflector from hood. No loose parts.
- New G. E. Turret Lampholders spaced 5 inches on center. Safety spring action eliminates possibility of lamps falling from vibration.
- High-power Factor ballasts. U. L. approved. Units fabricated and wired A. F. of L., I. B. E. W.

SPECIFICATIONS

Catalog Number	Number of Lamps and Wattage	Voltage Cycles	Shipping Weight
TWO and THREE LAMP 96" SLIMLINE — 430 M.A.			
24308 PT	2-75 W (T12)	110-125 V	50 lbs.
*24308 ST	430 MA	60 C	55 lbs.
34308 PT	3-75 W (T12)	110-125 V	49 lbs.
*34308 ST	430 MA	60 C	66 lbs.
TWO and THREE LAMP 48" SLIMLINE—430 M.A.			
24304 PT	2-38 W (T12)	110-125 V	31 lbs.
*24304 ST	430 MA	60 C	28 lbs.
34304 PT	3-38 W (T12)	110-125 V	41 lbs.
*34304 ST	430 MA	60 C	38 lbs.

*Suffix "S" in Catalog number indicates Synthetic baked enamel. Does not carry RLM labels. All units fabricated and wired IBEW, AF of L. The above units can also be supplied with Series type ballast which are E.T.L. approved. Half blank sections can be supplied. Prices on request.

BRIGHT LIGHT REFLECTOR COMPANY
INCORPORATED
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FAIRFIELD and STATE, Bridgeport 5, Conn.

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Write for Complete Literature

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Only a LABEL

. . . but it means your constant assurance of uncompromised quality!

Each ADVANCE BALLAST must pass the most exhaustive tests for efficiency . . . the most rigid examination for perfection of workmanship . . . the most careful inspection . . . before the ADVANCE LABEL is affixed.

One of a complete line of FLUORESCENT BALLASTS.

ADVANCE TRANSFORMER CO.

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(Continued from page 41A)

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. . . will benefit your customers with "Light-Conditioning"

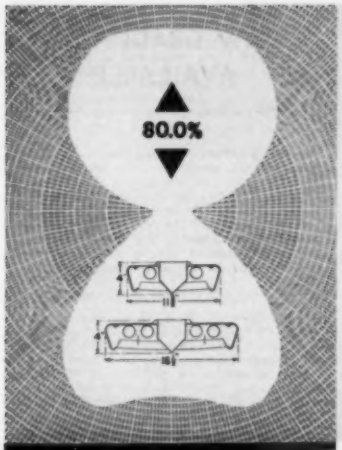
ALREADY, close to two million copies of General Electric's new lighting recipe booklet have been placed in the hands of the public. Offer of the booklet on the Fred Waring Television show, in spot radio commercials and magazine ads has produced many additional thousands of requests.

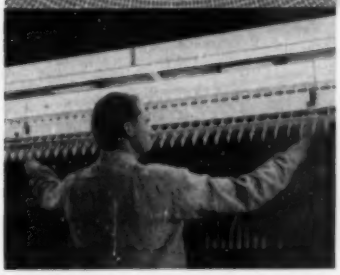
"See Your Home in a New Light" is sure-fire! Make the most of its tremendous appeal by using it to promote "Light-Conditioning" in your community. Prepared by General Electric home lighting specialists, the new book covers every major home lighting situation.

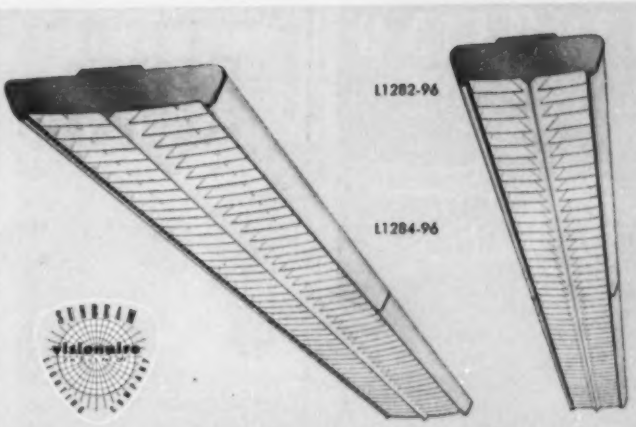
22 recipes give detailed information on lighting, such as exact measurements for lamp placement, for every purpose in the home.

General Electric is making the lighting recipe booklet available at nominal cost in any quantity you require for broad distribution. For full information and suggestions on methods of distributing it, call your G-E Lamp District Office. General Electric Company, Lamp Department, Nela Park, Cleveland 12, Ohio.

GENERAL ELECTRIC







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A new Sunbeam series (#L1280) combining simplicity of line and structure with an accent on easy maintenance. Only 4" deep, these new units have been designed to meet the needs of contemporary architecture, for a high output, non-recessed light source that is visually unobtrusive yet has high distribution efficiency. A one-piece, easily displaceable louver shielding element which exposes lamps (and wiring if desired) for immediate inspection, is the key to the reduction of high maintenance costs, generally found in today's large area lighting installations. Available for immediate delivery, this new series will be specified for stores and offices everywhere. Watch for it. For complete details write...

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24 complete job descriptions for use of lighting engineers and consultants; electrical contractors; architects; dealers; anyone concerned with practical data on outstanding lighting installations. Each sheet furnishes details of reflectance qualities, fixtures used, light output, installation facts.

24 sheets in all delivered to you in three lots—first eight available now on heavy paper for rugged field or office use. Single subscription, $1.25; quantities of 24 or more for lighting staffs, $1.00 each.

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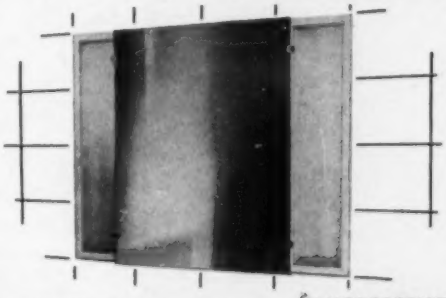
First with completely recessed lighting



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Now you can specify good lighting for the bathroom, too! The Milwaukee provides completely recessed lighting—for glareless, shadowless illumination. With *four* 20-watt fluorescent lamps, no other illumination is ordinarily needed in the bathroom. For all facts on this modern cabinet, write for Bulletin B-108. Or see your electrical wholesaler today.

CHECK THESE SPECS: Uses four 20-watt lamps, shielded with Corning Alba-Lite translucent opal glass. Trigger-start G.E. ballasts. All-welded 20-gauge cold-rolled steel. Mitered corners, filled and polished. Double-baked white lifetime enamel finish. Mirror of mirror-glazing quality polished plate glass. U/L approved. Union made. G.E. electrical equipment. 110-120 volts, 60 cycle a-c. Individually packed. Requires a wall opening of 30⅜ x 24⅜ x 4 in.

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LIGHTING
the finest
from coast to coast

Gibson Model 5500
highly efficient louvered fixture

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The most efficient louvered fixture on the market (85.5% by E. T. L. Analysis) . . . other large installations where well diffused high intensity lighting is desired. Available in 48" and 96" lengths.

Write today for catalogue showing this and other Gibson Fixtures.

GIBSON *Manufacturing Co.*
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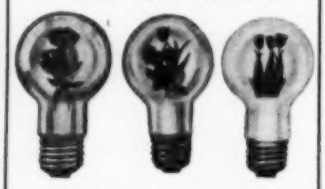
Something New in Light Bulbs

ELECTRIC FLOWERS

soft-soothing long wave spectrum light



Ionization of rare gases fashion the flowers inside of bulb in light in their natural garden colors!

Bulbs fit standard socket and operate on any home electric supply —consumes 2 watts—long life.

Offers opportunity of many new fashions in home decorations and subdued lighting.

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AEROLUX LIGHT CORP.
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FLUORESCENT STARTERS

AIR-THERMAL *features*

- Approximately 50% longer lamp life —because lamps are lighted with one starting cycle
- Operate at 90-125 line volts
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other features

- Automatic cut-out (no-blink)
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APPROVED BY

Guaranteed for two years.
Technical literature available.

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NEW GRADUATES AVAILABLE

Another graduate from the University of Illinois will be available after commencement, June 17, 1951. He will have a B.S. degree in electrical engineering (illumination option). Veteran, no reserve status, 25 years old, unmarried, interested in design or sales, and would like to locate in the Midwest near Chicago. For further details, contact John C. DeVore, 604 E. Armory, Champaign, Ill.

City College of New York, graduate June 1951, B.E.E. Student member of I.E.S., A.I.E.E., I.R.E. Cooperative work experience in making lighting survey in college. Desires work in application and design of lighting installations. Prefer Eastern location. Available June 15. Walter Novik, 393 E. 10th St., New York 9, N. Y.

B.S. in E.E. from Case Institute of Technology, Cleveland. Graduate June 9, 1951. Available June 25. Prefer location in upper or western New York State. Work desired—application or sales-application in illumination. George R. Poore, 1338 Newland Ave., Jamestown, N. Y.

1950 Electrical Engineering graduate, Case Tech. (Draft 4-A). Desires position in the illumination field, primarily lighting design and layout. Prefer warm, dry climate. Have six months' management training and six months' experience in power and lighting design with prominent engineering-construction firm. William J. Kerr, 3690 Gary Ave., Lorain, Ohio.

Junior in illuminating engineering at University of Illinois would like temporary position for months of June, July and August in Chicago for all types of labor in which experience could be gained for future work in sales. Please contact Melvin Cohen, 1421 S. Komensky, Chicago 23, Ill.

Engineering management opportunity! June 1951, E.E. Graduate, C.C.N.Y., veteran, 27, with six years of diversified experience in engineering construction and estimating, electronics, and foreign trade. Available for position offering definite opportunity for a career in engineering management. Business administration training at Columbia. Byron Vatses, 61-17 68th Ave., Brooklyn 27, N. Y.

Electrical and illuminating engineer available. B.E.E.; Graduate June 1951, C.C.N.Y. Illumination one of major subjects; worked on illumination survey. Will accept position anywhere in eastern U.S. Veteran, 25. Resume and interview on request. Address: Arnold Sher, 319 E. 79th St., New York 21, N.Y.

Illuminating Engineer, to be graduated from C.C.N.Y. June 1951 with B.E.E. degree. Member I.E.S. Desires employment with firm specializing in illumination. Good scholastic background in theory and design. Prefer position in New York City area. Please address correspondence to Alvin B. Daly, 135 Remsen Ave., Brooklyn 12, N.Y.

Student, Electrical Engineering, illumination option, University of Illinois. Available after graduation in February 1952. B.S. Degree. Design work preferred. Location immaterial. James J. Burke, 7739 Eberhart Ave., Chicago 19, Ill.

Graduate Electrical Engineer, University of Denver. Six years' experience with local manufacturer in fluorescent luminaire design and testing. Directed projects in illumination lab. on annual Engineers' Day. President of Pi Mu Epsilon, national mathematics honorary fraternity. Interested in research, development and application of fluorescent lighting. Available June 1951. Location of employment unimportant. Fred Leffler, 1357 Perry St., Denver 4, Colo.

Graduating from University of Illinois August 1951. B.S., E.E., illumination option. Available after August 25. Desire sales work. Prefer to locate in western states. John C. Simpson, Lovington, Ill.

Graduate of University of California January 1951 with B.S. in Electrical Engineering. Option was taken in illumination. Prefer job in field of illumination. Available after June 20, 1951. Masoto Okamoto, 2536 College Ave., Berkeley 5, Calif.

Philadelphia area. Cornell, B.E.E., 1950. Illumination and industrial engineering. Employed presently as industrial engineer, but desires position with illumination firm on industrial problems. Richard M. Rabkin, 712-A Park View Apts., Collingswood, N.J.

Summer job in illumination field wanted. Will have completed three years in the illumination option of E.E. at the University of Illinois as of June 9, 1951. Age 21. Possibility of being inducted into armed services. Location desired: St. Louis, Mo. Ben L. Stahlheber, 108 S. 9th St., Wood River, Ill.

1951 B.S. graduate in Electrical Engineering with major in illumination desires position as sales engineer in South. Available on August 15, 1951. References on request. Charlie G. Trevillion, c/o McGehee Lumber Co., Natchez, Miss.

Sales Engineer—graduating June 17, 1951. University of Illinois, B.S. in Electrical Engineering with illumination option. Veteran, five years' service, no reserve status. Available after graduation. Five years' previous employment. B. D. Richards, 2439 W. 32nd Ave., Denver, Colo.

Position wanted with illuminating engineering firm willing to expand business in India with Indo-American collaboration. Possess engineering (electrical) degree from M.I.T. and Cornell, and engineering and commercial experience in India and abroad. Completing Ph.D. from Cornell. R. P. Misra, Franklin Hall, Cornell University, Ithaca, N. Y.

WANTED

FIXTURE DESIGNER

Experienced fluorescent and slimline fixture designer. Large Pacific Coast manufacturer has excellent position for right party. Send full information. Address Box 142, Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

GOOD LIGHTING

15% of all INDUSTRIAL ACCIDENTS can be traced to IMPROPER LIGHTING!

The formula for Good Lighting is the combination of proper equipment and simple methods of maintenance. The Abolite Duo-Move System encourages regular cleaning habits because Duo-Move units can be cleaned and relamped quickly and safely without using clumsy ladders. Merely a twist of the wrist—reflector and lamp assembly can be removed and serviced—another turn and it's back in position . . . no interruption to workers . . . no lost time. The Abolite Duo-Move System guarantees maximum illumination with minimum service expense. Write for the Duo-Move story today!

THE JONES METAL PRODUCTS CO.,
West Lafayette, O.

WHITER THAN WHITE
ABOLITE Lighting

WHEN PLANNING *INDUSTRIAL* LIGHTING
KNOW WHAT YOU SHOULD KNOW
ABOUT
COLONIAL COLD CATHODE
LAMPS AND FIXTURES

Industrial fixtures
4', 6', 8' long
using 2, 4, 6 lamps

RATED LAMP LIFE 15,000 HOURS! MANY LAST 25,000 HOURS!

IMPORTANT FACTS

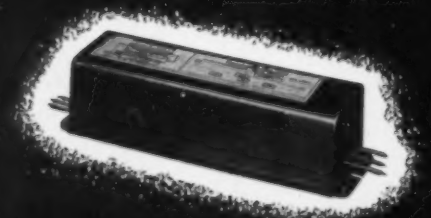
- LOW GLARE
- NO STARTERS (INSTANT START)
- LIFE NOT AFFECTED BY NUMBER OF STARTS
- LONG LIFE REDUCES MAINTENANCE
- STROBOSCOPIC AT MINIMUM
- NOT AFFECTED BY NORMAL VIBRATION
- SUITABLE FOR DIMMING
- SUITABLE FOR OUTDOOR USE

1. Constant Voltage Transformers
2. Baked Enamel Finish
3. Union Made
4. Underwriters Approved

Write for catalogs and information

COLONIAL ELECTRIC PRODUCTS, INC.
115 MARKET ST., EAST PATERSON, N. J.

QUIET MEANS
QUALITY



The core and coil assembly of an Acme Electric Ballast is made to such a high standard of excellence that normal magnetic hum is minimized and then further silenced thru impregnation. Assembly is sealed in the case, solidly imbedded in heat and cold resisting compound. Noise free operation is assured.

ACME ELECTRIC CORPORATION
295 WATER STREET CUBA, N. Y.

Acme ACME Electric

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...Just to service lights?

PLANT ENGINEER: *%&S#*! We specified *hangers* . . . not hinges! We want to lower the lights, not the whole roof!

CONTRACTOR: Hangers? What kind of "hangers" bring lights down for servicing?

THOMPSON HANGERS! They lower lights to floor or ground level for safe, low-cost maintenance.

Well who climbs up to lower them? And what about fouled wiring and electrical hazards?

Listen! Full control is exercised from the floor. The fixtures are lowered by a chain or cable that's part of the installation, and the live contacts remain overhead.

Then how are they repositioned, and what holds 'em up?

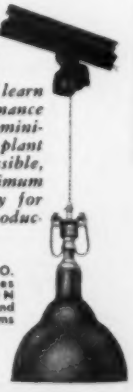
Repositioning is automatic because of the unit's design. Once raised, the light is held positively in place. It's safe and foolproof!

Sounds like a tricky operation. I'd like more details.

The whole operation can be accomplished in less time than it has taken me to tell you about it.

And you can get complete information from The Thompson Electric Co. Write for their new Catalog No. 50. You're in for a surprise, mister, on the hows and whys of efficient lighting fixture maintenance!

There's no obligation in requesting a Thompson Electric catalog. Why don't you write for one today, and learn how to cut maintenance costs to absolute minimum, make new plant safety records possible, and maintain maximum lighting efficiency for round-the-clock production operations?



CATALOG NO. 50 describes THOMPSON HANGERS and accessory items in detail.

172 TR

THE THOMPSON ELECTRIC CO.

1116 Power Avenue • Cleveland 14, Ohio

NO ROOM FOR GLARE—Corrugated white translucent PLEXIGLAS panels form a 600-square-foot, wall-to-wall luminous ceiling in this laboratory of the Excel Pharmacal Company, in New York City. Throughout the room, the evenly diffused illumination provides pleasant, efficient lighting. Note the low source brightness and minimum brightness contrast between ceiling, floor, walls and working surfaces. The lapped acrylic plastic panels are suspended on T-bars 14" below fluorescent tubes running parallel to the corrugations.

PLEXIGLAS Luminous Ceiling Passes Tough "Lab-Lighting" Test

Lighting gets a real test in Excel Pharmacal Company's laboratory—where critical visual tasks demand the best possible illumination. The PLEXIGLAS luminous ceiling passes that test easily—diffuses light completely—virtually eliminates glare and shadows—creates a luminous environment, easy on the eyes and nerves.

PLEXIGLAS acrylic plastic also simplifies the design, installation and maintenance of lighting systems. Because it is so easily cut, shaped and fabricated, PLEXIGLAS is being widely used in coffer and cove lighting, as overhead diffusing panels, and for completely enclosed fixtures. Strength and light weight make it easy and economical to ship and erect. And resistance to discoloration and breakage cuts maintenance costs to a minimum.

In more and more laboratories, drafting rooms, schools, offices—wherever close visual work makes *efficient* lighting essential—you'll find PLEXIGLAS. For full details of this durable, light-diffusing acrylic plastic, simply write us on your business letterhead.

CHEMICALS FOR INDUSTRY

• A steadily increasing percentage of PLEXIGLAS production, now at record levels, is required for the defense mobilization program. The supply available for civilian applications is limited.

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.*

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 54 Duke Street, Toronto, Ontario, Canada*

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

CERTIFIED BALLASTS are *Quiet*

Audible "humming" from a fluorescent ballast is highly annoying . . . yet some people believe this noise is an unavoidable part of fluorescent lighting.

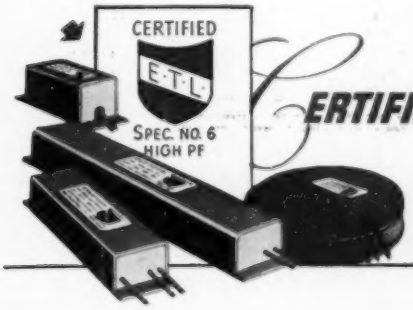
This is not true. Seldom do you hear a **CERTIFIED BALLAST** that is properly installed in a fixture. It operates efficiently and quietly.

Freedom from noise is but one advantage of **CERTIFIED BALLASTS.** You also get...

- Maximum light output (poor ballasts may reduce light by 20%)
- Full lamp life (poor ballasts may shorten lamp life by ⅓)
- Long, trouble-free, dependable service.

CERTIFIED BALLASTS are made to exacting specifications, then tested and checked by Electrical Testing Laboratories, Inc.

• Complete information on the types of CERTIFIED BALLASTS available from each participating manufacturer may be obtained from Electrical Testing Laboratories, Inc., East End Avenue at 79th Street, New York, New York.



Participation in the CERTIFIED BALLAST program is open to any manufacturer who complies with the requirements of CERTIFIED BALLAST MANUFACTURERS.

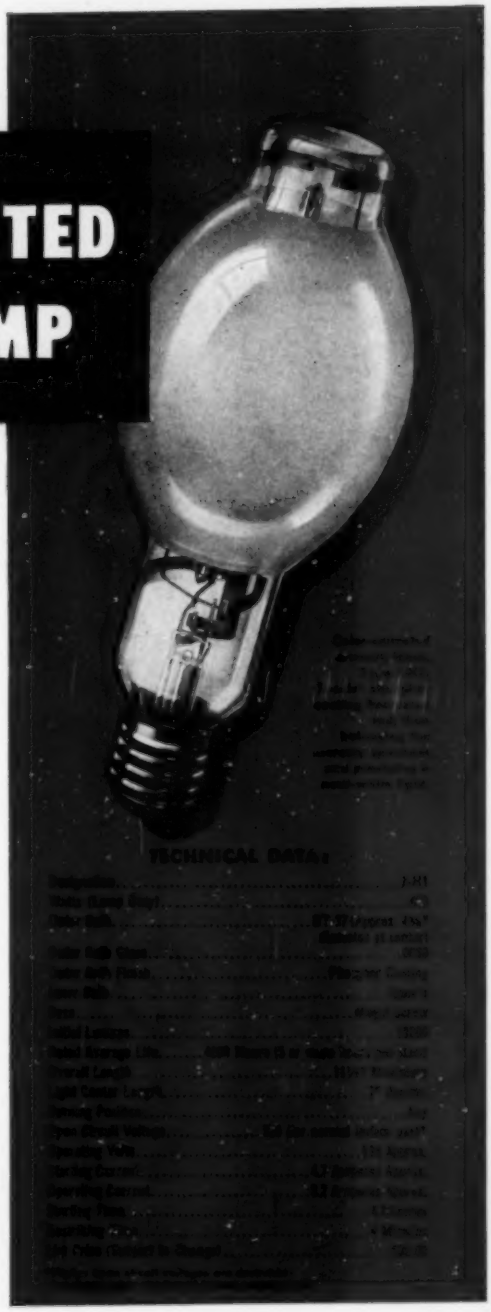
CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

NEW!

COLOR-CORRECTED MERCURY LAMP



EXCLUSIVE WESTINGHOUSE DEVELOPMENT COMBINES HIGH EFFICIENCY WITH WARMER COLOR

A new type of mercury lamp that has the familiar mercury-lamp advantages of high output and high efficiency *and a warmer color than previous models*, is now available from Westinghouse.

This color-corrected lamp is rated 400 watts, 18000 lumens, and is called Type J-H1. Electrically, the lamp is like the 400-watt A-H1 and E-H1 types. It will operate from H-1 ballasts, burn in any position, and fit most 400-watt mercury fixtures.

A principal advantage of the new lamp is that its use will preclude the necessity for a large percentage of incandescent lamps which previously served to provide color correction. Consequently, the lamp should find considerable service for industrial lighting, floodlighting and street lighting.

At present, the lamp is available in limited quantities, primarily for trial installations. For more information about it, write the Lamp Division, Westinghouse Electric Corporation, Bloomfield, New Jersey.

YOU CAN BE SURE...IF IT'S

Westinghouse